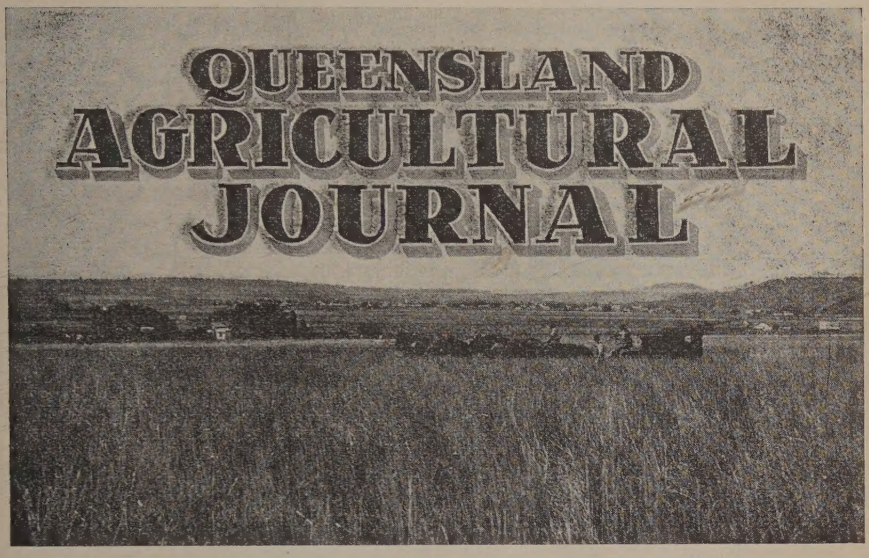
ANNUAL RATES OF SUBSCRIPTION.

Farmers, Graziers, Horticulturists, and Schools of Arts, **One Shilling.** Members of Agricultural Societies, **Five Shillings,** including postage. General Public, **Ten Shillings,** including postage.



VOL XLII. 1 JULY, 1934. PART 1.

Event and Comment.

The Tobacco Industry in the North.

REFERRING to a proposal that the State Government should take over the Tobacco Experiment Farm at Mareeba, which was established some years ago by the Commonwealth Government, which is now abandoning the project, the Minister for Agriculture and Stock, Hon. Frank W. Bulcock, informed the Press recently that he could not agree to such a proposal. The Commonwealth Experiment Farm at Mareeba had, no doubt, fulfilled its purpose up to a point. The Commonwealth Government, however, had not given his Department any details of its work, results, or policy at Mareeba. He had no figures indicating its cost of upkeep, nor had any other essential information been made available to his Department. In the circumstances, Mr. Bulcock said, to take over the farm would be literally buying "a pig in a poke." Moreover, if acquired, the expense of its maintenance would lead inevitably to a limitation of the more practical and diversified form of research already instituted by the Department of Agriculture, and which alone could produce the detailed knowledge of soil, climatic, and other conditions affecting the tobacco crop, and of which growers were in urgent need.

Far from neglecting the tobacco industry in the North, the Minister added, the Government had considerably strengthened its instructional staff in that division at the expense of other agricultural industries. At the present time there were altogether five field officers at Mareeba and Dimbulah, engaged solely on instructional and experimentation work associated with the tobacco-growing industry. In addition, the services of local officers of the Entomological and Pathological staff had been made available to the tobacco growers in those districts. The extension of the work of his Department along the lines already planned would yield information of greater value to the tobacco growers generally than could be expected from a continuance by the State of the Federal Tobacco Experiment Farm at Mareeba.

Experiment Plot System Organised.

PAST experience with tobacco and other agricultural crops, continued Mr. Bulcock, had shown that experiment work, as distinct from purely research work, to be of the maximum practical value to growers as a whole must be designed to embrace all of the soil types and variations of climate and locality associated with production of commercial crops. For that reason, his Department had adopted a policy of replacing experiment farms with a well-organised system of experiment plots throughout a particular district. In the last two years most of the money available for agricultural experiment had been applied, almost exclusively, to the development and extension of the tobacco experiment plots for the purpose of assisting the grower in the most practical way. Previously that work had been confined to a few small, scattered, exploratory plots varying in area from a quarter of an acre to an acre, and situated in widely separated parts of the State. Tobacco experiment work in the far North was limited to one locality alone—Mareeba. Under the present Government sixty local experiment plots had been established with a range of trials covering plant classification, propagation, crop rotation, and fertilization, as well as varietal tests. Of that number thirty-nine were situated in the far North, including twenty-two in the Cairns district. From these more up-to-date methods, information of immense practical value to growers, had been made available in every locality so served.

The additional Commonwealth grant of £1,250, which it had been claimed should be used by the State for carrying on the Mareeba Tobacco Farm, and which would otherwise permit of an extension of the more practical Departmental scheme, was not given for investigatory work in one particular locality, but in the State as a whole. To curtail the practical field work of his Department, which was of benefit to every grower in the North, as well as in other parts of the State, merely to enable a purely local experiment station to be carried on, could not be justified on the facts, financial or otherwise. Having regard for the wide variation in soil types and every other controlling factor, the continuance of such a station could only benefit a few local growers farming country similar to that on which the station was established. In any case, equally valuable information could be gained by the more practical plot system by all the growers concerned, including, of course, those farming in the immediate vicinity of the station.

The General Position of the Tobacco Industry.

MR. BULCOCK added that he was deeply concerned with the position of the tobacco growers in the North, as well as in other parts of the State. Everything that could be done by the State Government would be done to relieve the situation. Regarding the position of the tobacco industry generally, the present unsatisfactory position must be attributed largely to the reduction of duty on imported leaf and the increase in excise on home-grown leaf. In this respect North Queensland growers were not alone in their feeling of the effects of the present Federal fiscal policy.

In respect to the marketing of Mareeba leaf particularly, there had, apparently, been no fixed standards of buying, and the buyers had shown surprising inconsistency in their purchases. No definite information had, seemingly, been received by the growers from the manufacturers as to grades, quality, and quantity of leaf necessary to meet manufacturing requirements.

The fact remained, concluded Mr. Bulcock, that while a considerable quantity of usable Australian was left unsold—the best of it in some cases not even attracting a bid—the volume of imports showed little diminution. Up to approximately 17,000,000 lb. of foreign-grown leaf was imported into Australia last year. As the Australian consumption was about 20,000,000 lb., the margin in favour of the Australian producer was lamentably small.

Heavy Cane Crop in Prospect.

IN his preliminary estimate of the Queensland cane crop the director of the Bureau of Sugar Experiment Stations (Dr. H. W. Kerr) says the yield this year will be 4,516,000 tons of cane, as compared with the record tonnage of 1933, when 4,667,000 tons of cane were milled. Heavy tonnages of cane will be harvested in most mill areas again this year. The beneficial rains experienced in the Southern districts during the past growing season have resulted in the production of the heaviest crops recorded in those parts during the past ten years.

It is probable that the early forecast will be reduced considerably before the harvest is completed, due to the extraordinarily heavy flowering which is being experienced in all districts, he adds. Where the canes have "arrowed," no further growth will take place, and there is a possibility that much of the crop will be overmature before it is harvested. Early reports from those mills which have commenced crushing, and preliminary tests from other areas where harvesting has not yet begun, suggest that the cane is this year rich in sugar, in contrast to that of 1933. Allowing 7·1 tons of cane to produce 1 ton of sugar, the sugar yield on the above estimates will be 636,000 tons, as compared with an actual yield of 638,000 tons for 1933.

Farm Training Schools.

THREE farm training schools on similar lines to the establishment at St. Lucia, near Brisbane, may be opened in country districts in the near future. In making this announcement recently, the Minister for Agriculture and Stock (Hon. Frank W. Bulcock) added that it had been decided to make an inquiry as to suitable sites and that the investigation would cover the Central and Northern Divisions of the State; and that it was probable that a farm training school would be established at Kairi Experiment Farm on the Atherton Tableland.

Queensland Citrus Scale Insects and their Control.

By W. A. T. SUMMERVILLE, M.Sc., Assistant Entomologist.

(Continued from page 591, Volume XLI.)

SCALICIDES.

INSECTICIDES are classified, in accordance with the manner in which they affect the insect, in three groups—stomach poisons, fumigants, and contact insecticides.

As scale insects draw their food supply from beneath the surface of the plant the only method of administering a stomach poison would be by introducing it into the sap of the plant. Experiments with this object in view have been carried out in various countries, and in the course of the work on scale insects of citrus in Queensland a number of substances claimed to be effective in this way were tested. However, no success has so far been achieved here, and from the reaction of the plant to those substances which have been tried there does not appear to be much hope of success in obtaining a general distribution of any chemical throughout the plant by injecting it into any one part. From observations on the apparent resistance of particular trees to certain species of scale insects it appears possible, however, that if the correct material could be found and the plant made to absorb it in the same way as it ordinarily does its food, the sap might be rendered unsuitable for certain scale insects. This is mere theory, however, and as there is no known way of effectively polluting or altering the sap of citrus, the artificial control of scale insects must be accomplished by the use of fumigants and contact insecticides.

FUMIGANTS.

The only fumigant discussed in the control of citrus scale insects will be hydrocyanic acid gas, which can be produced in a number of different ways in the orchard.

Hydrocyanic Acid.

Since Coquillett, who was investigating the control of cottony cushion scale in California at the time, demonstrated the value of hydrocyanic acid gas as a scalicide and placed its use on a practical basis, this material has become more and more commonly used for such a purpose in many parts of the world, and is generally regarded as the most dependable lethal agent known for the control of insect pests. The acid and many of its derivatives are extremely poisonous, not only to most insects but to higher animals, and great care must be exercised in handling these substances to which the general name "cyanide" is applied. The fumigant has no significant ill effects on the tree provided certain conditions are observed, but if the limit of these conditions be exceeded the trees may be severely injured. In so far as orchardists are concerned there are two important physical properties of the gas. It is colourless, and its presence can therefore be detected only by the smell, which resembles that of bitter almonds, and it is lighter than air and therefore tends to rise and diffuses rapidly in ordinary atmospheres. The gas may be produced in the orchard by the reaction of

sulphuric acid or water on a derivative of hydrocyanic acid, or by the volatilization of liquified acid. These methods will be discussed separately under the headings of the chemical chiefly concerned.

Potassium Cyanide.

For many years all the hydrocyanic acid gas used in fumigating citrus trees was produced by the so-called "pot" system. This method has been largely displaced by other more convenient ones, but it is still used to a considerable extent in Queensland, and owing to increasing costs of the more recently introduced methods there are indications that the old "pot" method may again become the most commonly used.

With this method the required amount of water is placed in an earthenware jar and good commercial sulphuric acid, equivalent in volume to one-third of the water, is added. The jar is then placed in position under the sheet (see procedure lower down) and the required amount of potassium cyanide is dropped quickly into the jar. If the jar be shallow a piece of sacking placed over the mouth is useful to prevent spurting. The required amounts of chemicals are determined by reference to a table prepared for the purpose. (See Table II., page 22.) It is important that the correct amount of water be used. In all cases the proportion of water, acid, and cyanide is 3:1:1, where the amount of cyanide is expressed in ounces avoirdupois and the liquids in fluid ounces. If too little water be used the reaction may not go to completion, and if too much be present the amount of available gas is again reduced. If pure sulphuric acid be used the product may contain an appreciable amount of another gas which is very injurious to plants. In practice the potassium cyanide used is not pure, but is a mixture of potassium and sodium cyanide and a little inert matter. Generally a value of the article in terms of its equivalent to pure potassium cyanide is declared.

This method has a number of objectionable features. From the point of view of those doing the work it is both cumbersome and dangerous. The work must be done at night, and measuring the highly-corrosive sulphuric acid and handling the very poisonous potassium cyanide is very unpleasant work. From the point of view of the grower there is the extra cost of night work, the increased depreciation of equipment, and the lack of continuity of work commonly experienced on account of unsuitable atmospheric conditions.

The efficiency of hydrocyanic acid gas as a scalicide was shown by Knight[9] to be dependent on both the concentration and the length of time the insects are enveloped. That is to say, the smaller the amount of gas the longer it will need to remain to kill the insect. There is a definite minimum below which the gas is not lethal no matter how long it be present, and the upper limit of concentration is dictated by the reaction of the tree to the poison. When generated by the "pot" method the gas is hot and is evolved quickly, and thus diffusion is very rapid. In practice very rapid diffusion means rapid leakage, and thus concentration of the fumigant may be so quickly lowered that there is a considerable drop in efficiency. For this reason the "pot" method is not the most satisfactory way of producing the fumigant. An exception, however, appears to be provided in the case of pink wax, and the "pot" method has been found normally to give better results against

this species than the other systems in which the fumigant is evolved more slowly. It would seem that with pink wax the time factor is of less importance than with most other citrus scale insects.

Calcium Cyanide.

Fumigation by the use of calcium cyanide is the most commonly used method in Queensland at the present time. When calcium cyanide interacts with water hydrocyanic acid gas is produced. In citrus fumigation practice the calcium cyanide in a finely-divided state is brought into contact with the water vapour of the atmosphere. The rate at which the gas is evolved depends on the amount of water vapour present and the rate at which this can come in contact with the active material. The rate at which the water vapour can reach the material depends to a large extent on the surface area of the solid, and thus this rate will be increased as the size of the particles of the solid is diminished. The state of division of the material is therefore of importance. There are a number of forms of calcium cyanide marketed in Queensland, but only two proprietary lines are used to any extent in citrus fumigation. These are Cyanogas and Calcid Briquettes.

Cyanogas for citrus fumigation is manufactured in two forms—"A" Dust and Cyanogas G. The former is a finely-powdered material and the latter more granular. In theory the G grade should be the safer and better form for citrus fumigation, but growers generally prefer the "A" Dust. Provided attention is given to conditions the "A" Dust is perfectly satisfactory under Queensland conditions, and the only injury noted after extensive use of this material has been burning of lemon fruits when a good distribution of the dust was not obtained.

Calcid Briquettes represent a more recent method of citrus fumigation. This method has not yet been adopted to any great extent in this State, but it has much to commend it. In fact, in experimental fumigation work the best results obtained against all species of scales other than pink wax were obtained with this material.

In using calcium cyanide in either of the above forms, all that is necessary is to introduce the material under the tent and obtain as good a distribution as possible. In the case of Cyanogas the most commonly used method is to blow the dust under with a forge type blower, but owing to the cost of such a blower many growers throw the dust in by hand. The dust is placed in a shallow tray, such as a saucer, and thrown in with a sweeping motion. This is effective, but precautions must be taken to obtain a good distribution of the dust. If the dust be merely thrown in and allowed to fall in heaps, the risk of burning is considerable, and at the same time the probability of effective fumigation of the scale insects is appreciably lessened. The use of a blower is strongly recommended, but the hand method may be used provided the necessary care be taken. In the case of Calcid Briquettes it is essential to use a grinding machine, and for this purpose a specially-designed machine is obtainable. This grinds the briquettes finely and delivers the powder under the tent.

The methods of obtaining hydrocyanic gas by the use of calcium cyanide have much to commend them. No corrosive acid is employed; calcium cyanide, though poisonous, is much safer to handle than potassium cyanide; the work can be carried out in daylight under a

wide range of climatic conditions; and the whole operation is very simple. The manner of evolution of the gas is such that the leakage factor is definitely reduced, and in no case observed has severe burning been caused when correct precautions were taken. The results obtained against all species of scale are highly satisfactory, and, except in the case of pink wax, are superior to those obtained with the "pot" system.

Liquid Hydrocyanic Acid.

Since 1918 the use of liquid hydrocyanic acid has largely displaced all other methods in California. The liquified acid is drawn to a machine known as an applicator. This machine measures the dose and delivers the liquid under the tent through an atomising nozzle. On reaching the air the atomised liquid is immediately converted to the gaseous state. This method eliminates most of the objectionable features of the old "pot" system, both from the point of view of actual work and efficiency as a scalicide. Liquid hydrocyanic acid, however, has not yet been introduced into this State, and under present circumstances its introduction would scarcely be a commercial success. If, however, the difficulties of marketing it at a reasonable cost could be overcome, the liquid would almost certainly be the most satisfactory form in which to use the fumigant.

Possible Fumigation Injury.

Fumigation injury, or, as it is commonly termed by growers, "cyanide burn," is fairly distinctive in type but is occasionally mistaken for fungous trouble. Leaves may be merely spotted, or, particularly if tender, have an appearance very similar to frost burn. The injury to the twigs is similar. The trunk and main limbs are seldom damaged, but patches of dark dead bark sometimes appear when careless application causes calcium cyanide dust to lodge in a heap on the tree as it sometimes does in a fork. Such injury to woody parts is commonly followed by gumming. When the "pot" method is used, emptying vessels close to the butt of the tree may cause the death of bark and roots nearby.

On the fruit, fumigation injury is somewhat variable. The most common type is a pitting of the rind. These pits may surround a patch of dead tissue which imparts a scab-like appearance to the area. At other times, especially in the case of lemons, on the upper portions of the fruit, particularly those in contact with the sheet, there may be a brown or light-green area, which, if the fruit remain on the tree, turns to a somewhat bronze colour.

Badly injured leaves and fruit fall quickly, and very small fruits rarely survive the slightest injury. In cases of severe burning twigs may be killed back to the limit of hardened growth, whilst in the worst cases the dead tissue may extend a foot or more back from the tips.

CONTACT INSECTICIDES.

The following contact insecticides will be discussed in the succeeding paragraphs:—Oil sprays, lime sulphur, washing soda wash, soap and washing soda mixture, oil-soap-washing soda spray, and resin-soda-fish oil spray.

Oil Sprays.

The occurrence of varieties and species of scale insects resistant to hydrocyanic acid gas greatly stimulated research work on oil sprays in

the United States of America. As the result of the investigations carried out by de Ong,[10] Ralph H. Smith,[11] Woglum,[6] and others, there is now a fuller conception of the manner in which oil sprays act and a far better understanding of the essential properties of an effective and safe oil spray.

Kerosene emulsion may be regarded as the forerunner of the present day oil sprays. This material fulfilled one requirement in that it was reasonably effective. The emulsion, however, is rather difficult to prepare and gives very little margin of safety to the trees, and was displaced by the miscible oils.

Miscible oils are refined petroleum oils in which is dissolved a soap or some other such substance which enables the oil to be readily mixed with water to produce a stable emulsion. These miscible oils have been in use for a considerable period.

Following miscible oils another type of oil spray known as oil emulsion was produced. These oil emulsions are prepared by dissolving an emulsifier such as calcium or ammonium caseinate in water and adding the oil. When violently agitated the mixture breaks up into small globules and forms a stable emulsion.

In California a third type of oil spray is finding much favour and is now generally recommended. This is the so-called tank-mixture type. The pure oil is added to the water in the spray tank and an emulsifier, commonly powdered blood albumen spreader, is stirred in, and the whole then violently agitated. The agitation is a most important part of the preparation and must be maintained throughout the spraying. The greatest advantage of the tank-mixture spray is that growers are thus enabled to prepare an oil spray of known and definite properties. In practice two grades of oil are supplied, a light oil and a heavy one. By mixing these in various proportions a number of different grades may be produced in accordance with the requirements of the trees to be sprayed. The greatest drawback to this type of oil spray in so far as Queensland at present is concerned is that machines capable of moving a large-sized agitator at 200 revolutions per minute do not form part of the spraying outfit of any orchardist, and most machines in use would have to be discarded since that agitation is essential. This, however, would not prove an insuperable barrier in many cases, but the proprietary brands of oil sprays now available are for the most part so satisfactory that tank-mixture oils are not likely to be used to any extent in this State under present circumstances.

The greatest practical result of the research work mentioned above, in so far as Queensland is concerned, has been the production of the so-called white oils. These white oils represent a distinct advance on the old red miscible oils. The improvement is not so much in increased toxicity to the scale insect, for though some white oils are superior to any red oil certain red oils are definitely superior to many white ones in respect to toxic effect on the scale insect. The great advantage of the white oils is the increase in the safety of the trees, and in this particular the difference between the two is great, and much of the objection to the use of oils on citrus disappears when white oils are used.

The scalicidal value of an oil depends on both the efficiency of the material as a lethal agent on the pest and on its effects on the tree. These properties are governed largely by the purity of the oil, the

volatility of the oil, that is, the rate at which it will dry and evaporate, and the amount of the oil left on the tree after spraying. The purity of the oil depends on the extent to which unsaturated hydrocarbons are present. These unsaturated compounds, which are very poisonous to the plants, are removed from the crude oil by the use of sulphuric acid, and the purity of the oil is expressed in terms of the percentage which remains unchanged when treated with sulphuric acid. By modern processes oils can be highly refined without undue increase in cost, and this represents one of the most important advances made with respect to oil sprays. An oil, to be quite safe as a spray material under most conditions in Queensland, must be about 90 per cent. pure. Most of the white spraying oils marketed in Queensland fulfil this requirement. There are, however, a small number which are appreciably less purified, and though these may be employed under certain circumstances care must be taken to observe the conditions of use. Generally it has been found that the less pure oils must be used at considerably lower temperatures than would be quite safe for those fulfilling the condition given above.

The more volatile an oil the quicker it will evaporate, and as oils must remain on the insect for a certain length of time to cause death, too light an oil cannot be used for scalicidal purposes. However, when an oil spray remains on the plant it penetrates the tissues to some extent, and the longer it remains, within certain limits, the more oil there will be absorbed by the plant. A little oil may be absorbed without appreciable ill effect, and the more vigorous the plant the greater the amount which may be absorbed without prejudice to the health of the plant. In larger quantities, however, the absorbed oil may cause death to the part. Thus, though to effect a kill of the scale insect an oil must not be too light, it must not be so heavy that the plant is adversely affected. Under Queensland conditions the use of heavy-weight oils is fraught with danger.

When an oil spray lodges on the tree the emulsion is broken down and the oil and water separate. The rate at which this separation takes place depends to a large extent on the efficiency of the emulsifier. If the quantity of spray which falls on a leaf is not more than actually required to wet it, all the oil in that amount of spray will, of course, remain on the leaf. In actual spraying, however, in order to ensure that every part of the tree is covered, much of the tree will receive a great deal more spray than is actually necessary to wet it. As soon as, say a leaf, it wetted any further spray lodging on it will commence to run off. It has been shown experimentally that when free oil comes in contact with a wetted surface it does not necessarily run off but may build on the oil already deposited. Thus, when the spray lodges on the wetted leaf, if the emulsion breaks quickly some of the oil will remain to build up, and the run off will contain less oil than would be the case were the emulsion to break slowly. As the amount of oil deposited on the tree directly affects the scalicidal value, the quicker breaking the emulsion the greater the efficiency of the spray against the insect. It is, of course, possible to have a too quick breaking emulison, for the more oil there is left the more there will be absorbed into the tree. In practice, however, quick-breaking emulsions are necessary, and emulsifiers which satisfy in both particulars are generally used. The emulsifier also influences the spreading qualities of the spray, and in this again is an important component of any oil spray. For

reasons which are apparent from what has been stated above, the better the spreading quality the quicker breaking the emulsion required. It may be said then that, to a large extent, the lethal value of an oil spray increases as the margin of safety to the tree decreases, and as all oil sprays are chemically very similar the difference in brands is caused, to a very large extent, by the methods and substances used in effecting a compromise between the two. In so far as the brands of white oils marketed in Queensland are concerned it may be said that the safety of the tree has apparently been fully considered, and further that with those brands used at all extensively there has been little loss in insecticidal efficiency to bring about this result. In purchasing any of the brands of white oil at present sold extensively in the State, growers will obtain quite satisfactory spray material. Other brands, however, will no doubt appear, and growers should protect themselves by obtaining information on the essential properties as outlined above before purchasing.

The following are the data concerning two typical oil sprays of good quality:—

White Oil—

Unsulphonated Residue, 95 per cent.

Viscosity (Redwood) 1 at 100°F., 60-70 seconds.

Red Oil—

Unsulphonated Residue, 75 per cent. to 80 per cent.

Viscosity (Redwood) 1 at 100°F., 155 seconds.

It is essential that oil be applied to the trees well emulsified with water. Whilst growers almost always attend to the production of such an emulsion before the application commences, too often inefficient agitation is given whilst the spraying is in progress. The number of spraying outfits in the State which have either a very poor agitator or none at all in the vat is remarkably high. The ill effects of an oil spray are magnified by such a state of affairs, and the provision of good agitators must be treated as an urgent necessity.

Possible Ill Effects of Oil Sprays.

As has been stated above the white oils are very much less harmful to citrus trees than are the red. This, however, cannot be taken to mean that white oils are wholly beneficial to the trees. However, if used correctly these white oils are very useful sprays and can be recommended for the control of several species of scale insects. There is, however, much needless use of oil sprays in Queensland. Too often oil is used in the hope that it will control a pest. The attitude which should be taken is to use oils only when it is known that these will be successful. There is no doubt that a great many of the trees in Queensland which have never or rarely been sprayed with oil are superior in general condition to comparable trees which are regularly so treated. This refers to general effects, which may perhaps be termed cumulative.

Possible direct ill effects are varied. Generally, however, they are the result of failure to observe the conditions laid down with respect to oil spraying in general. Probably there is some little direct damage every time an oil is sprayed onto a citrus tree, but if precautions be taken these ill effects can be reduced to insignificance. Almost any part of the tree may be adversely affected. Roots and the base of the

trunk are sometimes damaged by allowing an accumulation of oil to remain in contact with them after it has run down the trunk. The damage is most severe in the case of young trees, and with such it is wise to hill the soil up round the base of the trunk before application and to remove the mound shortly afterwards. Leaves, twigs, and fruit may be severely injured, and dropping of portion of the crop, particularly when the fruit is small, is possible. Partial or total defoliation of the tree may also be caused by the injudicious use of an oil, and in such cases a large proportion of the twigs may be killed back 6 inches or more. Less severely damaged leaves and fruit may remain on the tree, and these are usually spotted with brown markings or pitted, and the fruit thus rendered unsightly and depreciated in market value. Crop reduction may be caused in several ways, such as by the reduction of blossoming, or by the dropping of young fruit, and through the general health of the tree being impaired and the size and number of fruit being thus reduced. Retardation in colouring, both on the tree and in the colouring chamber, may also be caused by oil sprays. For this reason it is advisable to pick lemons immediately before spraying.

Trees in poor condition are much less able to withstand the ill effects of oil sprays than healthy ones, and allowance must always be made for that fact. A tree suffering from lack of water should never be sprayed with oil. As oils penetrate the plant it is obvious that the oil sprayed in the winter will affect the plant more than if applied during a period of free growth. Oils therefore should not be applied to citrus trees during a dormant period. Trees sprayed with oil during the winter have been kept under observation, and in some cases no great direct ill effect has been noted at the time. In every case, however, the oil has had some appreciable ill effect. Lighter blossoming, weakening of fruit-bearing wood, and premature heavy leaf fall are almost always to be noted. In other cases both direct and indirect effects have been observed. The maximum temperature at which a white oil should be used is about 100°F. At this temperature healthy trees not lacking water may be sprayed safely. However, it is recommended that oil spraying should be carried out in as cool weather as possible, taking into consideration the essential points concerning the pest being combated.

Growers should follow closely the directions given by the manufacturer of an oil. These include provision for maintaining an emulsion. Growers often complain that a certain brand of oil caused burning to their trees. No grower who has not an efficient agitator in his spray vat can possibly attribute injury to the spray oil as such. The oil and water should be measured. Haphazard guessing is the cause of much trouble. The procedure for mixing an oil spray is simple. The required amount of oil is measured into a tin and about twice that volume of water added. The emulsion is obtained either by pouring the mixture backwards and forwards several times from one container to another, or by forcing the mixture through a fine nozzle with a bucket pump. When the oil has thus been emulsified it is further diluted by being added to the bulk of the water in the vat.

Lime Sulphur.

Lime sulphur is a complex mixture of polysulphides of calcium together with small quantities of other compounds containing calcium, sulphur, and oxygen. It is a most useful spray material, and is probably

the one material which should be used on every citrus orchard in this State every year. Formerly lime sulphur was used extensively as a scalicide against a number of species, but for this purpose other substances, particularly oils, have displaced it to a very large extent. In Queensland at the present time lime sulphur is used for the control of one species only, namely white louse. At the same time it is effective to a certain extent against the crawlers of several other species of citrus scale insects, and in using lime sulphur against white louse a certain degree of control is exercised against these other species. Liquid lime sulphur is the form most commonly employed, and all recommendations for the use of this spray on citrus in Queensland refer to this form. In some parts of the world dry lime sulphurs are used to a certain extent, but the scalicidal value of these appears to be definitely lower than with the wet sprays.

For the most part, commercially made lime sulphur is employed, but the mixture can be prepared on the farm if so desired. Particulars of the preparation of home-made lime sulphur are to be found in "Pests and Diseases of Queensland Fruits and Vegetables," by Robert Veitch and J. H. Simmonds, a handbook published by the Department of Agriculture and Stock. Generally speaking, the home-made lime sulphurs are not altogether satisfactory. It is quite commonly found that the home-made operation may be successful several times and the next quite unsuccessful, though no known variation in the procedure has been adopted. A few citrus growers in the State do make their own lime sulphur and find it quite satisfactory, but it is considered that, on the whole, purchasing the manufactured concentrate is more satisfactory.

The strength of lime sulphur is indicated by the density, and to determine this a Baumé hydrometer is necessary. Concentrate prepared by the method given by Veitch and Simmonds will usually be found to be between 24° and 28° Baumé. It is the common experience in making home-made lime sulphur to find that the densities of successive lots vary considerably. Further, even commercial brands vary from one another, and even between different samples of the one brand. All recommendations for the use of lime sulphur at certain strengths are based on the assumption that the concentrate is about 32° or 33° Baumé, and it may therefore be necessary to make adjustments with different lots of concentrates. The following table, taken from "Pests and Diseases of Queensland Fruit and Vegetables," will enable the adjustments to be computed readily:—

TABLE I.

Density of Stock Solution in Degrees Baumé.	Dilution Required Based on a 33° Baumé Standard.				
	1 to 10.	1 to 15.	1 to 20.	1 to 30.	1 to 40.
25	7·6	11·4	15·2	22·7	30·3
26	7·9	11·8	15·8	23·6	31·5
27	8·2	12·3	16·4	24·5	32·7
28	8·5	12·7	17·0	25·5	33·9
29	8·8	13 2	17·6	26·4	35·2
30	9·1	13·6	18·2	27·3	36·4
31	9·4	14·1	18·8	28·2	37·6
32	9·7	14·5	19·4	29·1	38·8
33	10·0	15·0	20.0	30·0	40·0
34	10·3	15·4	20·6	30·9	41·2
35	10·6	15·9	21·2	31·8	42·4

It must be remembered, however, that of itself the density of lime sulphur gives little true idea of its insecticidal value, and because two such solutions are both 33° Baumé it does not follow that the insecticidal efficiencies are equal. The value of lime sulphur as an insecticide or fungicide has been shown to depend largely on the polysulphides present, and to gauge accurately the strength of the concentrate the percentage of polysulphides must be known. If, therefore, there is any doubt as to the composition, an analysis must be made if definite information is to be obtained.

Lime sulphur is used at strengths varying between one part of the concentrated stock solution to ten parts of water, and one part of the concentrated stock solution to thirty of water, or more according to the purpose for which it is required and the time of the year at which it is to be applied. The higher the prevailing atmospheric temperature the more dilute the lime sulphur must be. At strengths less than 1—15 lime sulphur has little value as a scalicide on citrus. It is the practice in some orchards to use this material regularly much stronger than 1—10, but such strengths are very rarely required for any purpose, and whilst little damage to the tree may result, lime sulphur is not a particularly cheap material and excessive strengths should therefore be avoided. With strengths such as 1 to 4 which are sometimes used in the winter little direct injury may be noted, but there is some reason for thinking that normal blossoming may be affected.

Correctly used lime sulphur is one of the most beneficial sprays known for citrus, at least in so far as Queensland is concerned. All the damage done by this spray is caused through using over-strengths. On the trunk and main limbs which are at all effectively protected from the sun, lime sulphur may be used at almost any strength at any time, but during the summer months foliage and tender twigs may be badly burned if the strength be greater than about 1—20, and in the hottest times of the year 1—30 or 1—35 is as strong as the material should be applied. Injured leaves are quickly shed, and fruit may also fall. More generally, however, burned fruit remains on the tree even if injured when quite small. If young fruit be injured the marking may grow in size with the fruit, and thus a very small amount of original injury may cause a considerable blemish to the rind of the mature fruit. As a scalicide lime sulphur is not used at less than about 1 to 12, and, therefore, its use for this purpose is confined to that period of the year when the only trees bearing fruit would be lemons and perhaps late valencias.

Washing Soda Wash.

A wash containing 1½ lb. washing soda to 4 gallons water formerly was used extensively for the control of wax scales, but it is now rarely used in Queensland, its place having been taken to a very large extent by the following mixture of soap and washing soda.

This spray has been displaced mainly on account of its rather drastic action on the trees. Under Queensland conditions the wash to be effective must be used in rather warm weather and severe injury to leaves and tender twigs frequently follows its use. The effect is particularly bad on weaker trees, and partial or even total defoliation may occur. In addition to this injury the washing soda spray has a definite tendency to harden the bark, and on healthy trees this is the greatest

objection to its use. The spray, however, cannot be considered a dangerous one to trees in good condition provided it is not used too regularly.

Soap and Washing Soda Mixture.

This mixture is made according to the following formula:—24 cakes Sunlight soap, 12-14 lb. washing soda, and 75 gallons water. To prepare the spray, dissolve the washing soda in as much water as can be boiled conveniently, and then add the soap. The soap will dissolve more readily if it be shredded. The mixture is then heated until all the soap has dissolved. Unless the quantity of water be very small it will probably not be necessary to actually boil the solution. The concentrate thus prepared is then diluted to 75 gallons in the spray vat. The mixture should be well agitated during the application. The spray is essentially a foliage one, and the application should be liberal.

Common soap may be substituted for Sunlight, but in no case have the results with other soaps equalled those obtained with the Sunlight. Clean fresh washing soda only should be used in making the mixture.

The addition of the soap is found to allow of considerable reduction of the washing soda without greatly impairing the scalicidal efficiency against the principal wax scale, that is, the pink wax, and at the same time the reduction in the amount of soda definitely reduces the harmful effects of the soda as described for the old washing soda wash. The soap tends to cause the spray to spread better, and assists in this regard also. The possible ill effects are similar to those given for the straight washing soda wash, but, as indicated, are felt to a considerably lessened degree.

Oil-Soap-Washing Soda Spray.

A combination of the soap and washing soda spray with oil is sometimes of value as a scalicide, especially when it is desired to combat mussel and pink wax concurrently. The mixture is also more effective against mussel scale than is straight oil. It is advisable to reduce the amount of soap and soda. In experimental work satisfactory results were obtained with the following proportions:—8 cakes Sunlight soap, 8 lb. washing soda, 1½ gallons oil, 75 gallons water. Oil and washing soda without soap is sometimes used. In hot weather, however, this spray is likely to cause severe burning to the leaves, and it is always advisable to include soap in the mixture. The soap spreads the spray well and prevents its accumulation into drops which is generally responsible for the burning that results.

Any injurious effects following the use of this spray are mainly attributable to the oil it contains, and the damage is comparable to that done by oil alone. In some respects this spray is rather more drastic than straight oil, however, and its use should be confined to late summer and autumn months.

Resin-Soda-Fish Oil Spray.

This mixture gives a most efficient scalicide spray. Its greatest value is in the control of complexities of pests which include scale insects, but were it not that the preparation is rather cumbersome and requiring some little time, its use could be extended with considerable benefit. In those instances where it is recommended growers will find that they are fully compensated for the extra time and work involved

in its preparation. The formula of the spray is 10 lb. resin, 3 lb. caustic soda of good commercial quality, 1½ lb. fish oil, preferably herring oil, and 40 gallons water. The procedure for preparing the spray is as follows:—Firstly grind up the resin as finely as practicable, and then either mix the resin and the caustic soda while dry and add the mixture of these solids to 2 gallons water, or dissolve the caustic soda in the 2 gallons water and add the resin slowly while the solution boils gently. Generally the latter procedure is adopted. Whichever method be used the mixture must be boiled until a clear dark solution is obtained. The solution expands when hot, and if the volume of water be much in excess of half that of the container boiling over may occur. The fish oil is added to the clear dark solution when this is obtained, and the whole boiled for a few minutes to ensure that no free oil remains. The concentrate thus prepared is diluted for use with cold water. The agitator should be kept running while the application is in progress. If the concentrate is to be stored the fish oil should not be added before storage unless the mixture can be kept in perfectly airtight containers. When the concentrate cools a certain amount of solid is deposited, and thus when large lots are being prepared it is necessary to divide the stock solution while hot. This may be done by reheating stored lots or dividing up as soon as prepared. As most spray vats in use in Queensland have a capacity of either 40 or 75 gallons, the stock solution will be divided into lots of 2 or 3¾ gallons. The former method is preferable as it enables the addition of the fish oil at this stage to be made in such a way that thorough mixing is easy and assured.

In addition to its scalicidal value the spray has many beneficial effects on citrus trees, and if made correctly and applied at the right time it is an excellent general spray for these trees. It is, however, important to prepare the spray carefully, otherwise severe injury may follow its use. It is essential that the clear dark liquid described above be obtained, and all cases of injury to trees following the use of this spray in cool weather have been attributable to carelessness in preparation.

This spray must not be used in the very hot weather, and, in general, application should not be made when the temperatures exceed 90° F. Its general use, however, is restricted to periods when the temperature is about 10° lower than that maximum. If used in too hot weather severe burning followed by fall of both leaves and fruit may occur. Injured leaves and fruit are usually marked with a sticky deposit. This deposit may be present to a slight extent on uninjured parts, but does not persist on these, and the fruit may be covered with the material within a few days of being harvested.

COMBINATION SPRAYS.

It is possible under certain circumstances to mix a scalicide with a second spray to produce a combination which may be used with safety on the trees, and which at the same time retains the insecticidal or fungicidal properties of each of the constituent materials. Where this can be done it is very desirable for reasons both of economy and convenience. In mixing two spray materials in this way there are often precautions to be adopted, and because two such materials are stated to be compatible it does not necessarily follow that direct mixing can be done. Orchardists should therefore familiarise themselves with the

details of the preparation of such combinations. The following mixtures which include scalicides are of value to citrus growers in this State.

Lime Sulphur and Oil.

To a certain extent the mixture of oil with lime sulphur comes under the heading of both combination and simple spray. Whilst the properties of the lime sulphur for purposes other than the control of scale insects are preserved, the mixture also forms a spray which, under certain circumstances, is a better scalicide than the straight oil. Most miscible oils do not form stable emulsions in the presence of lime sulphur unless a special emulsifier be added. The emulsifier or stabiliser for the purpose is casein. The casein is dissolved in the water and the previously emulsified oil is then added. This mixture is agitated well and the lime sulphur then added. The amount of casein required varies with different oils and different lime sulphurs, but generally 1 lb. of casein to each 100 gallons of spray suffices. There are a number of white oils on the market which can be mixed directly with lime sulphur, and when the combination is desired they are usually preferable. Such oils are usually specially marked as directly miscible with lime sulphur.

Oil, lime sulphur combinations are very useful, but should be used with great care, as severe burning of fruit and foliage may result if the mixture be applied in very hot weather. The maximum safe temperature can be set down as about 90°F. It is, however, unwise to use the combination at the maximum temperature unless the trees be in good condition. In this State the use of the combination spray is therefore restricted to early summer and late summer or autumn months. The spray is particularly severe on young growth, and its use at times when there is much new growth cannot be recommended. It should not, of course, be used on dormant citrus trees.

Bordeaux Mixture and Oil.

Oil may be added to Bordeaux mixture to form a safe combination spray provided the oil be well emulsified before it be mixed into the other material. The procedure recommended is to use a good brand of oil, thoroughly emulsifying it with about double its own volume of water. When a good emulsion is obtained stir it well into the prepared Bordeaux mixture. The amount of oil to be used is generally mentioned as 1 per cent., but this amount can be exceeded by ½ per cent. without injury to the trees. The essential point to be observed is that there must be no free oil present at any time during the application. Whilst the 1 per cent. combination has some scalicidal value it cannot be recommended as likely to be of much value against heavy infestations of most scale insects. It is, however, of use on lightly-infested trees. The greatest point in favour of the mixture is the improved spreading quality of the Bordeaux.

Oil and Nicotine Sulphate.

Oil and nicotine sulphate may be safely mixed. A spreader is sometimes added to ensure greater safety, but this is not essential. Nicotine sulphate is, however, very seldom required on citrus in this State, being used on citrus only for the control of aphis. This insect rarely needs to be artificially controlled, and when this is necessary it is usually at a

time when the trees are very susceptible to injury from oil sprays. The combination is therefore of little value as a citrus spray in Queensland.

Lime Sulphur and Arsenate of Lead.

Lime sulphur may be mixed with acid arsenate of lead to form a very useful and safe spray combination. However, when used in this way lime sulphur is not being employed as a scalicide as a general rule, but for the control of Maori mite or red spider. On occasions, however, the combination may be used in connection with the control of scale pests. In mixing the two materials the lime sulphur is added to the water in the first place, the arsenate of lead being mixed separately into a paste in the same way as when the poison is being used alone. A little more water is then added to the arsenate of lead paste and the whole mixed into the lime sulphur solution.

Soap and Washing Soda and Burgundy.

Burgundy mixture may be combined with soap and washing soda mixture to form a combined spray for use against wax scales and fungi. The mixture is at times very useful. The two sprays should be prepared separately and mixed later. In experimental work a little burning was caused at times when full strengths of both constituents were used, and though this was never serious and not invariable, it is perhaps advisable to reduce the soap and washing soda in the scalicidal portion of the spray. It was found that the soap may be reduced to fifteen cakes and the soda proportionally without undue loss of scalicidal efficiency.

Soap and Washing Soda, and Nicotine Sulphate.

Soap and washing soda, as described in an earlier paragraph, and nicotine sulphate may be mixed together to form a useful combination spray. It sometimes happens that towards the end of summer, particularly in years when the rains have been falling over a protracted period, the late growth may not harden for a considerable time and the aphis then becomes somewhat of a menace and may need attention. In such years pink wax control may be required at a time at which the aphis can be conveniently combated. Under these circumstances the combination of soap and soda with nicotine sulphate may be of value. The nicotine sulphate is added to the soap and washing soda in the usual proportions, that is, ½ pint to 50 gallons.

Soap and Washing Soda, and Lime Sulphur.

This combination has a very limited use. It is only of value when a protracted hatch of pink wax has occurred, and it becomes necessary to combat pink wax and Maori at the same time. The spray must be used with great care, as severe burning often results. On no account must the amount of soap be reduced. The combination is too drastic to permit of its being generally recommended, but at times it may be of use.

COMPATABILITY OF FOLLOWING TREATMENTS.

There is no problem which citrus growers of this State have to face which gives more concern than the question of what sprays may be safely used in succession to one another. The trouble is due to a large extent to the use of fungicides containing copper compounds as the

principal ingredient. Once such a spray has been used many of the most useful scalicide materials cannot be employed for a considerable time. The search for substitutes for these copper containing sprays has so far met with little success. Attention has recently been directed to the use of zinc sulphate and lime as an alternative to copper sprays for certain diseases. This spray has so far not been proved to be of any value against the major fungous troubles of citrus in the State, and there does not appear to be much likelihood that this substance will be recommended as a substitute for Bordeaux or Burgundy mixtures for general use on citrus.

The question of compatability is, of course, not confined to the class of sprays just mentioned, but must be considered with other sprays also. It is advisable, therefore, in drawing up a programme of pest and disease control, to give full consideration to the compatability of all the sprays which may need to be used for the following twelve months. The more important following treatments are discussed below.

Bordeaux Mixture and Oil.

Although Bordeaux mixture and oil may be used as a combination spray care must be exercised in applying the two as separate sprays to the one tree. In general at least two months should elapse after an application of Bordeaux before oil is applied, and unless the removal of residual Bordeaux has been assisted by good rain it may be advisable to wait still longer. In practice, however, two months usually suffice, for unless an appreciable amount of rain has fallen in that interval the trees will not be in a fit condition to spray with oil. That Bordeaux may follow oil within a shorter period is of little value, for in the control of most of the major diseases of citrus in this State the initial fungicide application must be made early in the spring and the treatment repeated at least once before mid-summer. Thus the use of oils before Bordeaux cannot be recommended for reasons arising out of the use of oil alone. The only occasion on which the procedure may be required is when rots of the fruit such as are caused by *Phytophthora citropthora* Sm. et Sm. occur. This type of rot is uncommon and is only in evidence in wetter times. In such cases Bordeaux may be applied to trees previously sprayed with oil when desired, for the latter material will always have been used in the late summer or early autumn and the rots are never much in evidence until well into the winter.

Fumigation and Bordeaux Mixture.

The effect of fumigating a tree which carries a residue of Bordeaux is disastrous, and at least six months should be allowed to elapse after applying the spray before fumigation is carried out. Even in that length of time the procedure cannot be said to be entirely without risk. To definitely eliminate all possibility of damage the period would have to be almost twelve months. In experimental work a number of trees were fumigated less than three months after having been sprayed with Bordeaux and no injury resulted. This was done in a very dry period following one of heavy rain, and it would appear that under such circumstances the intervening period may be considerably reduced. However, if less than six months be allowed to elapse great care must be exercised, and orchardists should proceed slowly. As the damage to the trees is so great no chances should be taken, and in general it cannot be recommended that fumigation should follow Bordeaux spraying within six to eight months according to weather conditions.

Bordeaux mixture may, however, be applied quickly after fumigation. Although in theory the spray may be applied immediately after the fumigant has left the tree, in practice it has been found advisable to wait at least ten days.

Lime Sulphur and Bordeaux Mixture.

The use of lime sulphur against white louse in the late winter may need consideration in cases where Bordeaux is to be applied early in the spring. When these two materials are mixed a heavy black or dark-brown deposit, probably a copper sulphide, is formed. This precipitate is very insoluble, and apart from covering the trees does no damage. The reaction which brings about its formation, however, leads to a reduction in the efficacy of both spray materials, and the close following of one spray by the other in either order is therefore to be avoided as far as possible. In general the order in which the material will be applied in so far as scale insects enter into the question is lime sulphur first and then Bordeaux. The reverse order may be required when Maori mite or red spider control has to be undertaken. The question of spraying programme in these cases will be dealt with in connection with the control of such complexities in the discussion of the control of scales in various districts.

Bordeaux Mixture and Resin-Soda-Fish Oil.

These sprays may be applied within about a month of one another in either order without injury to the tree. In practice, however, there are few, if any, occasions on which Bordeaux will be required to follow the resin spray in so short a time. The reverse procedure is much more commonly called for, and as the sprays may be used in quick succession the resin-soda-fish oil mixture becomes a most valuable scalicide.

Oil and Resin-Soda-Fish Oil.

The resin-soda-fish oil spray should not be applied within less than at least three months of an oil. If the sprays be applied in that order in too short a time, heavy fall of leaf is probable and small twigs may be killed. In the experimental trees the injury to well-grown fruit was, however, slight. The reverse order of application is not likely to be considered and has not been tested.

Lime Sulphur and Oil, or Sulphur and Oil.

The problem of following lime sulphur or sulphur with oil can be overcome largely by the use of a combined spray of oil and lime sulphur. Where it is known that both materials will need to be used at about the same time the combination should always be used if conditions permit. In no case should oils be used immediately following sulphur dust or lime sulphur. In the case of lime sulphur the period between the two applications should be at least one month, but preferably longer. If the combination spray cannot be used owing to weather or other such circumstances, it is preferable to use sulphur dust rather than the lime sulphur for the control of mites.

Fumigation and Oil.

Fumigation may be followed by oil spraying, or oil spraying by fumigation within a few days without injury to the trees. Unless it be

unavoidable, however, it is wise to allow at least a fortnight to elapse between the treatments. There should never be any occasion in Queensland for requiring the two treatments within such a short period of one another. If it be known in advance that both these treatments will need to be given, it is recommended for preference that the fumigation be carried out first.

FUMIGATION.

Whatever method of generating the gas be used the procedure in fumigating a citrus orchard is essentially the same. The tree to be treated is first covered with a tent. These tents, or sheets as they are usually styled, may be of any material which fulfils the following conditions:—It must be of close enough weave to ensure that the gas will escape only very slowly, strong enough to stand the wear to which it will be subjected by being dragged around the orchard and over the trees, and not so heavy that it will be difficult to handle in this work. Most fumigation sheets in use are made of duck or drill. Drill is inferior to duck, and the most satisfactory material employed is special 8—10 oz. army duck. A medium weight calico of close weave gives perfectly satisfactory results in so far as the kill of insects is concerned. This material has the advantage that it is cheaper to purchase than the duck, but the life of a calico sheet is, of course, less than the stronger duck. Calico would perhaps appeal most to orchardists starting with an orchard which has not yet commenced to pay its way, and in this and other cases may be of considerable value. In the experimental work a medium weight close woven English calico, costing 1s. 6d. per yard (72 inches wide), was used. The results obtained with this were equal to those obtained with 10 oz. duck costing approximately 2s. 6d. per yard. Thus from about £25 to £30 will be saved by using the calico for an equipment of twelve sheets.

The sheets are usually eight-sided and are of various diameters. The number of sheets will depend on the size of the orchard and the means of the grower, but where possible an outfit should include at least twelve sheets, and twenty can be easily handled by a gang of four men who know anything about fumigation. The diameters will depend on the size of the trees, and in purchasing sheets due allowance must be made for the growth of the trees during the following five or six years. If given careful treatment a sheet should last at least that length of time, and it is unwise to acquire tents which will be of no use long before they are worn out. Sheets may be enlarged by adding an extra width of material to the edges, but it is much better to obtain whole sheets in the first instance. The smallest size sheet which should be purchased should be about 30 feet in diameter. If a sheet is to be enlarged drill may be used, as it is quite satisfactory to form the flaps towards the bottoms.

The size of the sheet required to cover a tree varies with the habit of growth of the tree, and it is difficult to give an accurate idea on this point. An Emperor of Canton mandarin 10 feet high, for example, will usually be covered by a much smaller sheet than a Scarlet of the same height. The sheet should reach well to the ground, and allowance must be made for that fact. Roughly it may be said that a well-shaped tree 10 to 12 feet in height will require at least a 33-foot tent, and more probably a 36-foot one will be needed. The largest sheets commonly used are 55 to 60 feet in diameter, though on some Queensland orchards 80-foot sheets are in use.

In order to protect the sheets from attack by mildew these are sometimes given a treatment with tannin. This treatment tends to lengthen the life of the tent, but there is no evidence that it increases its gas-holding capacity. The tents are treated by being dipped in a vat of hot tannin solution. They are immersed for about half an hour and then spread out on the ground to dry. The strength generally recommended is 40 lb. of bark to about 100 gallons of water, but as the tannin content varies a definite amount of water cannot be given.

In fumigating an orchard a tent is placed on the end tree of each row for as many rows as there are tents. The tent is hauled over the tree with the aid of one or two poles according to the size of the tent and tree. These poles should be light and at least 18 feet long for use in most orchards, particularly where lemons are grown. The essential point about the poles is that they must be sufficiently long to allow of the tent being raised in such a way that branches towards the top of the tree will not be caught under the sheet when it is being pulled up. With short poles limbs are frequently broken by being so caught, and the risk of the sheet being torn is greatly increased. From the first tree in each row the sheet is transferred directly to the next. That is, after the first tree each day the sheets are not again brought to the ground except at the conclusion of operations.

The dosage is calculated on the amount of space beneath the sheet. This depends on the dimensions of the sheet when in position. There are two systems in use—the distances over and around, and height and diameter. The former gives a rather more accurate result, but in Queensland the height and the diameter are the measurements almost always taken. These give sufficiently accurate data. The distance over the tree may be found most easily by marking the sheets, so that when in position the measurement is automatically registered, and in this case the distance around is obtained by running a tape around the outside of the sheet. The height may also be found by a marked sheet, but generally a light pole plainly marked in feet is used, and this pole is also used for determining the diameter. The markings must be plain enough to be readable when the pole is in the vertical position against the high trees. The dosage is determined by reference to tables specially prepared for the purpose (see Tables II., III., and IV., pages 22, 23, and 24).

If the "pot" method be used the only other equipment necessary is the earthenware pots and the various measuring vessels and supply vats. With any other method a machine is either necessary or desirable as described in connection with each in earlier paragraphs. If Cyanogas is being employed it is desirable to obtain a supply of specially-graduated spoons. These spoons hold exact known quantities of the dust and thus save any weighing and allow quick and accurate working.

Conditions and Precautions.

In almost every fumigation season numbers of trees are injured or poor results obtained against scale insects through neglect by fumigators to observe conditions which, for the most part, are quite well known. Fumigation is no work for a careless man, and, if the safety of trees and operators combined with good results against the pest are to be

TABLE II.

POTASSIUM CYANIDE.

45 MINUTES EXPOSURE.

Diameter of Tree (feet).

Height of Tree (feet).

	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
4	1	1	1	1																
5	1	1	1	1½	2															5
6		1½	1½	2	2	2½	3	4	4											6
7		1½	1½	2	2½	3	4	4	4	5										7
8				2½	3	3	4	4	5	6	6	6	7							8
9				2½	3	3	4	4	5	5	6	6	7	7						9
10				3	3	4	4	4	5	5	6	6	7	8	9					10
11					4	5	5	5	6	6	7	7	8	9	10					11
12						5	5	6	6	6	7	8	8	10	11	12	13	15	17	12
13						6	6	7	7	7	8	9	9	12	13	14	15	16	18	13
14							6	7	7	8	9	10	11	13	14	15	17	18	18	14
15								7	8	8	10	11	12	14	14	16	18	20	20	15
16									9	10	12	12	13	14	15	17	18	20	21	16
17										12	13	13	14	15	16	18	20	22	22	17
18											13	13	15	16	18	20	22	23	24	18
19												15	16	18	19	21	23	25	25	19
20													17	19	21	23	24	25	26	20
21													19	19	21	23	25	26	27	21
22														21	22	24	25	26	27	22
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	

Doses in Ounces.

Proportion: Cyanide, 1; Sulphuric Acid, 1; Water, 3.

TABLE III.

CYANOGAS DUST.

45 Minutes Exposure.

Diameter of Tree (feet).

Height of Tree (feet).	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
4	1	1	1	1½																4
5	1	1	1½	1½																5
6	1	1½	1½	1½	2	2½	3	4	4											6
7	1	1½	1½	2	2½	2½	3½	4	5	5½										7
8		1½	1½	2	2½	3	4	4½	5½	6½	7½	8½	10							8
9			2	2½	2½	4	4½	5	6	7	8½	9½	11	12½						9
10				2½	3	4	4½	6	7	8	9½	10½	12	14	15½					10
11					3½	4½	5	6½	7½	9	10	12	13½	15	17	19				11
12					3½	4½	6	7	8	10	11	13	14½	16½	18½	20½	23	25	27½	12
13							6	7½	9	10½	12	14	16	18	20	22	24½	27	30	13
14							7	8	9½	11	13	15	17	19	21½	24	26½	29	32	14
15								8½	10	12	14	16	18	20½	23	25½	28½	31	34	15
16								9	11	13	15	17	19½	22	24½	27½	30½	33½	36½	16
17									11½	13½	16	18	20½	23	26	29	32	35½	39	17
18									12½	14½	17	19	22	24½	27½	31	34	37½	41	18
19									13	15½	18	20½	23	25	29	32½	36	39½	43½	19
20									13½	16	18½	21½	24½	27½	30½	34	38	42	46	20
21												22½	25½	29	32½	36	39½	44	48	21
22												23½	26½	30	34	37½	41½	46	50½	22
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	

Doses in ounces.

Table recommended by manufacturer and used in experimental work.

TABLE IV.

CALCID BRIQUETTES.

40 MINUTES EXPOSURE.

Diameter of Tree (feet).

Height of Tree (feet).	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
4	1	1	1½	1½																4
5	1	1	1½	2																5
6	1	1½	1½	2	2½	2½	3	3½	4											6
7	1	1½	2	2	2½	3	3½	4	4½	5										7
8		1½	2	2½	2½	3	3½	4½	5	5½	5½	6	7							8
9			2	2½	3	3½	4	5	5½	5½	6	7	8	9						9
10				2½	3	3½	4½	5	5	6	7	8	9	10	11					10
11					3½	4	4½	5	6	7	8	9	10	11	12	13				11
12					3½	4	5	5	6	7	8	10	11	12	13	14	16	17	19	12
13							6	6	6	7	9	10	11	13	14	16	18	20	22	13
14							6	6	7	8	9	11	12	14	16	17	19	21	23	14
15								6	7	8	10	11	13	15	17	19	21	23	25	15
16								7	8	9	11	12	14	16	18	20	22	24	27	16
17									8	10	11	13	15	17	19	21	24	26	29	17
18									9	10	12	14	16	18	20	22	25	28	30	18
19									10	11	13	15	17	19	21	24	26	29	32	19
20									10	11	13	15	18	20	22	25	28	31	34	20
21												16	19	21	24	26	29	32	35	21
22												17	19	22	25	28	31	34	37	22
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	

Doses in Number of Briquettes.

Table recommended by manufacturer and used in experimental work.

ensured, attention must be paid to detail. The most important conditions which are to be observed may be briefly stated as follows:—

If the pot system is being used the work must be done in the absence of sunlight, for if this method be used during the day serious injury to the trees may result. Calcium cyanide, however, may be safely used in the day time, even on the brightest days.

It is essential that the dimensions of each tree be determined accurately. Guessing the dosage is very inadvisable.

The humidity of the atmosphere must be considered. Wet trees must never be fumigated, and generally it is wise to cease operations when there is any damp feeling in the air. With calcium cyanide humidity is usually of minor consideration, but when night work is being done dew often necessitates discontinuance. Very often work is commenced in the morning with sheets which are far from dry, and this leads to much trouble. When there is any chance of the sheets becoming wetted overnight, they should be placed under shelter. Even if they be but placed in a group and covered by one other sheet a good deal of time and trouble can be avoided. Wet sheets pick up much dirt and grit, and scratching of the fruit results from friction when the sheets are being pulled over the trees. Scratched fruits, besides being blemished, are more susceptible to cyanide injury than sound ones, and the sheets should therefore be kept as clean as practicable.

Temperature is of greater consideration than humidity as a rule. When the pot method is being employed fumigation should cease when the temperature is greater than about 75°F. in coastal parts and 80°F. in interior districts. When calcium cyanide is being used, however, the upper limit is much higher, and under most conditions healthy trees remain uninjured at temperatures 10° to 15° F. higher in both cases. In many cases trees have been fumigated with calcium cyanide in interior districts at 100°F. or even a little higher with very little or no ill effects. Care, however, must be exercised when working at these very high temperatures, and a close inspection made so that if any damage is being done it will not go too far. As a general rule on typical hot summer days in Queensland it is advisable to discontinue fumigation between about 12.30 p.m. and 3 p.m.

The tree should be covered for about forty-five minutes. Under good fumigating conditions, particularly if the humidity be fair to good, the interval may be reduced to forty minutes, but under no circumstances should the time be extended to more than about fifty minutes. There is nothing to be gained by increasing the time to an hour as is sometimes done, and there is distinct risk of injury. Further, it is not advisable to have the trees covered for any great length of time before the charge is applied.

The soil of the orchard should be sufficiently well cultivated to permit of the sheets making good contact, and often it is desirable to throw a little soil on the bottoms of the sheets so that they make close contact with the ground. The soil should not be so wet that the humidity of the amosphere enclosed by the tent will quickly be altered appreciably, and for this reason irrigation should not immediately precede fumigation. At the same time trees which are suffering from lack of water are definitely less resistant to the gas than others, and in general the healthy trees suffer less than those in poor condition.

Different varieties of trees show different tolerance to the gas. With the pot method lemons usually are found to be more resistant than oranges, and oranges more so than mandarins. With calcium cyanide, however, the order is different. Oranges are the most tolerant when this form is used, and lemons markedly the least. Under Queensland conditions, however, the order of tolerance is rarely of moment. Young growth in all cases is more susceptible to injury than is hardened growth, and when there is much new growth on the trees fumigation should be postponed as long as possible. In no case with trees other than lemons, where it cannot be avoided, should trees carrying fruit less than about three-quarters of an inch in diameter be fumigated. In ideal circumstances fruit which is well set is not usually affected to any appreciable extent, but fumigation is not to be recommended at so early a stage in the development of the fruit.

Care must be taken to see that the sheets are as gas-tight as possible. They must be touching the ground firmly all round, and all folds must be arranged so that they do not enclose any great air space. Careful inspection should be made at short intervals for tears, and these should at once be mended. Many tents become badly torn because small holes are not attended to early. Apart from the efficiency of the fumigation being lowered in the meantime, sheets are too expensive to treat in this way.

Fumigation is seldom effective if carried out in windy weather. The wind tends to increase the leakage, and fumigation under badly-flapping tents is useless. Furthermore, it has sometimes been observed that the kill is less on trees close to ones fumigated in windy weather than would normally be expected. It would appear possible that in such cases the insects on the former trees may receive sub-lethal doses carried to them by the wind and thus develop a tolerance to the gas. The resistance is small and does not apparently persist, but it is advisable for this reason, as well as others connected with the insects themselves, to work towards the wind and refrain from fumigating in very windy weather.

SPRAYING.

It is obvious that no matter how high the insecticidal efficiency of a material may be the insect must receive a certain amount before any result can be expected. In the case of contact insecticides in use against scale insects this means that the pest must be adequately covered by the spray. It is therefore necessary to know just how the material was applied before any assessment of its worth can be made. Bad spraying is much more common than bad sprays, and every year quite good spraying materials are condemned by growers who do not take into consideration the manner of application. It is by no means an easy task to spray a well-grown citrus tree thoroughly, and if satisfactory results are to be obtained against scale insects by the use of sprays, attention must be paid to details.

In spraying there are two important units—the man and the machine. For efficiency an active man is necessary, otherwise both time and material will be wasted. No man can effectively spray unless he gives the whole of his attention to the work. For this reason also a good horse is an asset, for if a man has to be continually speaking to and looking at the horse he cannot possibly give adequate attention to the work on hand.

It is advisable to work always to a system. Any system which ensures that the whole of the tree will have the maximum chance of being covered must include the following points:—The inside of the tree will be done first, and each branch will be traced out to its end. Special attention must be given to topmost parts. In spraying the outside it is necessary in the first place to make sure that the hose will reach to every part of the tree, and this can only be done by walking to the full length of the hose before commencing at each tree and then working back towards the machine. If this is not done it may be found on walking round the tree that the hose is too short to reach the point where the spraying began. If the unsprayed section be large it will be noticed, but in other cases it may be left unsprayed. In either case there will be loss of time or efficiency. If two men be spraying together they should work at an even pace, otherwise one man will be wasting time and material or the other will skimp the last part of many trees.

The spraying outfit of many Queensland growers at the present time is hopelessly inadequate, and if scale control is to be improved much of the present equipment will have to be discarded. There are a number of very satisfactory machines on the market for reasonable prices, and it must be remembered that efficient spraying is a very profitable undertaking.

It is impossible to spray a citrus tree effectively with a pressure of less than 175 lb., and for really good work at least 300 lb. is necessary. Of almost equal importance to high pressure is constant pressure. It is not possible to do efficient spraying when the pressure is fluctuating over a range of about 75 or 100 lb. as is often found to be the case. The vat should be fitted with a good strainer, and above all an efficient agitator. Too much emphasis cannot be placed on the necessity for good agitation in the vat. Many spray materials are harmful to both the pump and the hoses, and residual spray material should be cleaned out immediately after an application is completed. Apart from this, cleaning eliminates accidents arising at the following spraying through the unintentional mixing of two incompatible materials or the application of the first material at the wrong time. The frequency with which growers neglect to repair small defects in the spraying outfit until these are actually required for use is rather remarkable. The result is often much inconvenience and loss of valuable time.

The hose should be about 30 feet long and of good quality. The junctions of hose to the pump and the rod should be kept tight. Nothing wears a hose out more quickly than kinking when the pressure is on, and kinks can be avoided to a large extent if the operator make two half turns instead of one complete turn. The rod should be long enough to ensure that the tops of the trees can be well sprayed. Six feet rods are the minimum length of much value, and generally 8-foot lengths are required. Light bamboo rods have the advantage that they are thick enough to hold with comfort and they do not become greasy with spray as do the metal ones. One nozzle to each rod gives fairly satisfactory results, but two set on a Y-piece, so that the cones of spray intersect about 9 inches from the opening, give by far the best results. The orifice in the nozzle should be as fine as the spray material being used will permit, and it must be remembered that the holes are enlarged quickly by certain materials. Lime sulphur is the only scalicide requiring a nozzle which is at all coarse. Drench spraying uses more

material and does not give as good a cover on citrus as the mist. The spray rod should always be held at an angle so that the leaves are twisted and not merely pushed out of the way, as happens when the spray is directed flat on to the surface.

Spraying should not be commenced whilst the trees are wet, and should be discontinued at least half an hour before rain. Most sprays will require at least that length of time to dry, and this must be given consideration. Effective spraying is not possible in very windy weather. These points are very obvious, but the frequency with which they are ignored is remarkable.

Spot spraying could be practised to a much larger extent than is the case, but it is bad practice to neglect to treat a particular tree merely because it is unproductive. If a tree is not worth spraying it should be destroyed and certainly not left as a breeding ground for pests and diseases.

Any citrus tree with the normal amount of foliage is difficult to cover with spray, but those which are correctly pruned are certainly more easily so treated than others. As a preliminary to any spraying it is necessary to prune the tree, and, in general, trees should be kept as open as possible, having due regard, of course, for the other effects of this on the tree.

In mixing sprays it is essential that the ingredients be measured, and a good deal of the trouble which occurs would be avoided if this point were borne in mind. Fresh materials should be used, and if it be necessary to keep materials for any length of time they should be stored in airtight containers preferably in a cool place. Water is an important component of every spray. Generally rain water is available for this purpose, but if well or other water must be used it is necessary to have a test made to discover its suitability. A water is not necessarily fit for spraying because it is declared suitable for certain domestic purposes.

Lime sulphur is the only scalicide used to any extent on citrus in this State with which a spreader is advisable, and for this casein may be used. Some of the miscible oils do not spread very well, and with these a small quantity of soap improves the spreading qualities.

COMPARISON OF FUMIGATION AND SPRAYING.

Judged purely from the standpoint of efficacy against every species of scale insect on citrus, where it can be correctly carried out fumigation is preferable to spraying. Unfortunately, however, fumigation cannot be recommended for use in several of the largest centres of production. On the Blackall Range and in similar localities climatic conditions prohibit the use of the fumigant for the greater part of the year. Here winds are practically constant and wet days numerous throughout the period in which the work would have to be done, and the continuity of operations would almost always be badly broken. In these districts spraying must therefore be used for the most part.

In all districts the numerous small growers find the cost of equipment too great, for not only is the initial outlay high but depreciation has to be considered. Again, in many parts fumigation does not eliminate the necessity for a spray plant. Even though fumigation is effective against a large number of pests there are others—for example, the bronze bug—which must be considered, and diseases such as melanose

(*Phomopsis citri*) and black spot (*Phoma citricarpa*) must be combated with wet sprays. Further, whilst fumigation is undoubtedly superior against scale and many other pests, other satisfactory methods are known, and therefore where outlay of money must be considered primarily growers generally do not use fumigation.

TABLE V.

TESTS OF SCALICIDES.

Percentage Kills Obtained in Experimental Work. Poorest and Best Results given: Kills Calculated According to Method Detailed in Text.

——	Red Scale.	Circular Black Scale.	Mussel Scale.	White Louse.	Pulvinaria.	Pink Wax.	White Wax.
Fumigation—Pot method	95–98	96–99	97–99	98–99	*a*	92–97	*a*
Fumigation—Cyanogas	97–98	98–99	98–99	98–99	*a*	89–92	*a*
Fumigation—Calcid	98–99	98–99	*a*	98–99	*a*	93	*a*
Resin-Soda-Fish Oil	97–99	98–99 leaves 90–94 fruit	98–99	95–97	98–99	96–98	94–98
White Oil ..	94–97	97–98 leaves 85–92 fruit	87–93	89	94–95	*b*	*b*
Red Oil	94–97	97–99 leaves 87–92 fruit	89–93	89	94–95	*b*	*b*
Soap-Soda ..	*b*	*b*	*b*	*b*	*b*	94–96	88–91
Washing Soda ..	*b*	*b*	*b*	*b*	*b*	95–96	93–96
Oil-Soap-Soda ..	93–96	*a*	92–96	*a*	*a*	92–96	*a*
Lime Sulphur ..	*b*	*b*	*b*	94–97	*b*	*b*	*b*
Oil, Lime Sulphur	91–95	97–98 leaves 79–83 fruit	*a*	96	*a*	*b*	*b*

a No data.

b Scalicide of little or no value against particular pest.

At the same time fumigation is superior, not only in the action on scale pests but also because it is so much more thorough than the best spraying. For this reason, and because fumigation is effective against so many pests concurrently, it is almost invariably the most economical scalicide that can be employed in suitable districts. Where the outlay for equipment is not of paramount importance fumigation is to be recommended in preference to spraying. A good deal can be done by co-operative effort. A scheme whereby a group of orchardists purchases an outfit which is available to each member at all reasonable times for but a very little outlay has been shown to be practicable by the growers in the Gayndah district.

THE INFLUENCE OF BORDEAUX MIXTURE ON SCALE INSECTS.

The continued use of Bordeaux mixture on a citrus tree may profoundly influence the scale insect position, not only with respect to degree of infestation but also with respect to the species of scale insects present. It appears that the effects are produced principally in three ways—namely, by rendering the use of several important scalicides impossible without great risk of injuring the tree, by the destruction of entomogenous fungi, and by the effect of Bordeaux on the plant itself.

The first of these is at times the most important, but there is now some method by which the trouble can be overcome. In certain cases, however, even if the difficulty be surmounted by the use of an alternative scalicide there may be loss in efficiency resulting in increase in population.

The destruction of entomogenous fungi was at one time thought to be the outstanding, if not actually the sole, reason for the increase in scale infestation following the use of Bordeaux. This, however, does not appear to be the case, for the evidence collected during the course of this work indicates that it is only on very rare occasions that these fungi exercise any appreciable degree of control. Though the commonest fungi are found in every major citrus-producing district, in certain parts they are found only very rarely, and then but a few insects are affected as a general rule. However, it is almost invariably found that scale insect infestation increases whenever and wherever Bordeaux is used at all extensively.

It is considered that by far the most important factor in most cases is the effect of the spray on the tree itself. The effect is, of course, the more pronounced the more Bordeaux is used. For the control of most of the major fungous diseases of citrus in the State several applications of Bordeaux are necessary in fairly quick succession. Thus cumulative effects are the rule. It is known that the copper from the fungicide may be absorbed into the plant, and copper so absorbed may be incorporated into the chlorophyl, resulting in the destruction of that substance for the purposes of photosynthesis. It is possible that it is through the chlorophyl that the effect of the spray is felt, but whatever the actual process, it is certain that citrus trees repeatedly sprayed with Bordeaux lose vigour. Where very heavy applications are made the loss becomes visibly manifested in heavy premature leaf fall, reduction in crop, and production of much weak growth. It will be readily understood that scale insects are very sensitive to the condition of the tree, and loss of vigour is quickly indicated by these pests. It will be seen by reference to the habits of red and mussel scales that these species are quick to take advantage of weakened condition of trees. It is true also that it is these species which increase to the greatest extent following the use of Bordeaux. Were the position affected only by the destruction of the entomogenous fungi it would be expected that the species of scale originally or habitually present would show the greatest increase. This, however, is not the case. Thus in recently-conducted experiments Emperor of Canton mandarin trees which usually were found to carry an appreciable infestation of pink wax only were repeatedly sprayed with Bordeaux. On these trees pink wax soon became a very minor pest, and in fact on several trees was represented by but a very few individuals. At the same time both red and mussel scale, particularly the latter, increased to such an extent that at one stage it appeared likely that the trees would be killed, or at least very badly injured. These trees

were oversprayed for experimental reasons, but similar effects have been noted in many other cases. As all the species of scale mentioned are hosts of the commonest entomogenous fungus the decrease in pink wax can scarcely be accounted for in that direction. It is therefore considered that the increase in scale insect population following the use of Bordeaux in most cases cannot be attributed to the fungicidal action of that spray but to its adverse effects on the tree. Bordeaux mixture is a most valuable fungicide and must be used if certain of the more important citrus diseases are to be controlled. It is apparent, however, that when this material is to be used growers must take what action they can to ensure as good growing conditions as possible for the treated trees, and a scalicide must be included in the spraying programme for the year.

IMPORTANCE OF TIME OF APPLICATION OF SCALICIDES.

It is very commonly assumed that because a certain percentage of the scales on a tree have been killed that an equally good degree of control has been established. It is the common practice also for growers to submit specimens from sprayed trees asking for information as to the kill obtained. That the first assumption is unwarranted and how misleading the figures obtained in the second event may be is shown by the analysis of the results of the following experiments carried out during the course of this investigation.

In the first experiment trees heavily infested with red scale were sprayed during the early part of January. Counts made fourteen days after the application showed that approximately 98 per cent. of the red scales were dead. Six weeks later a further series of counts was made and the figures then available were:—

Average number of living scales per fruit before application—

Sprayed trees	31·2
Unsprayed trees	28·45

Average number of living scales per fruit at time of third count—

Sprayed trees	16·5
Unsprayed trees	401·6

Assuming the rate of reproduction on all trees to be the same, it will be seen that an apparent kill of 96·25 per cent. had been obtained. Allowing for errors due to inability to handle sufficiently large numbers of individuals, the kills computed fourteen days and two months after application agree fairly well. Taking the figures for the sprayed trees, it will be seen that although a kill of at least 96·25 per cent. had been obtained in January, at the end of February the trees still harboured half as many scales as when they were treated. Thus, though the lethal value of the spray was 96·25 per cent., the control value of the spraying by this time was less than 50 per cent., and of no commercial significance.

These trees were kept under observation during the following twelve months, and at no time were they commercially free of the scale. In the following January the average number of scales per fruit on the sprayed trees was 34·8 and the unsprayed 59·4. The sprayed trees were thus a little under 50 per cent. better than they would have been if left unsprayed.

In the second experiment, using the same spray against the red scale during the last week in March, the following figures were obtained:—

Apparent kill fourteen days after application, 97·8 per cent.

Average number of living scales per fruit before application—

Sprayed trees	396·4
Unsprayed trees	259·5

Average number of living scales per fruit at time of third count (that is, six weeks later)—

Sprayed trees	8·9
Unsprayed trees	283·0

Average number of living scales per fruit twelve months later—

Sprayed trees	1·3
Unsprayed trees	181·1

In this case at the time of the second count the figures show a lethal value of 97·94 per cent. and a control value of the spraying of 97·75 per cent. Further, these figures are more than maintained, for the trees at the end of twelve months were more than 99 per cent. better than they would have been if left unsprayed. It should be pointed out that comparisons of two trees over a period of twelve months may not always give valid data. In the interval the scales have been through five complete generations, and it cannot be assumed that conditions of life for the scales on all trees have been the same throughout the period. Red scale reacts quickly to the physiological condition of a tree, and, in turn, profoundly affects that condition; it is commonly found that at any one time parasites are more in evidence in crowded colonies than in sparse ones; the struggle for existence is not necessarily equal—to mention but one fact, it is a habit of red scale that the young settle down in close proximity to the mother, and therefore there must at times be considerable competition for food. However, it is quite obvious from the figures given that the lethal value of a spray and the control value of a spraying are by no means one and the same thing. In the first experiment from a 96·25 per cent. kill the control value in twelve months had become less than 50 per cent., whilst in the second, from a kill of less than 2 per cent. more the corresponding control value was approximately 99 per cent. The differences are caused by reason of the following. January is the month in which effective reproduction by red scale is at its highest, and February is also a period of prolific reproduction. From March onwards to the commencement of spring mortality is great, and reproduction is considerably retarded. Effective reproduction is again in evidence during the spring and early summer, but it is not until mid-summer that infestations multiply very considerably. That some of the trees improve without any treatment, or perhaps without further treatment, is due to several causes. In the first place the kill on the twigs is often better than on the fruit and the fruit is removed during the colder months. With the fruit a certain proportion of the scale is always removed. Natural mortality due to the work of parasites and predators and the influence of climatic conditions also vary. In the case of some of the trees in the second experiment the condition of the tree was certainly of limiting influence. As has been recorded above, red scale affects and is affected by the condition of the tree to a large extent. Thus, in the second experiment the control was such that the trees responded well during the following spring and the vigour improved to such an extent that the suitability of the tree to red scale

infestation was definitely lowered. This, however, cannot be dissociated from the control value of the treatment.

In the third experiment the species was pink wax scale. This is a slow-breeding pest, and control must be established against each of the two generations per annum. The spray in this case was applied approximately a month earlier than the time recommended. At the time of application 72 per cent. of the old scales were reproducing and young were plentiful. It is at such a time that many growers, becoming alarmed at the increase in numbers, apply control measures. In the case of this species the position is very different from what pertains in the case of red scale. There is no overlapping of generations, and the exact position is clear within six weeks or two months after reproduction is in evidence. Counts made on the trees used in this experiment gave the following figures:—

Average number of living young per leaf—

Sprayed trees	16·6
Unsprayed trees	153·0

In this case the migration of young is such an important factor that comparison of figures before and after treatment gives no significant information, and all that can be done is to use trees which are comparable in respect to pink wax infestation. From the above figures it would appear that a kill of 98 per cent. had been obtained. This figure was supported by counts of living and dead old scales, but as old scales fall very readily from the leaf after death the figures are not significant. However, examination of the figures in conjunction with what is known of the life history and habits of the scale show the assumption of a 98 per cent. control to be unwarranted. Many of the leaves on the unsprayed trees carried more than 200 scales, and it is obvious that that number will not survive. The amount of feeding space on the average leaf would not permit more than about half that number of scales to grow to maturity, and the competition for food would certainly be great, even with half the number. On the other hand, on the sprayed trees the maximum number of young on any leaf was twenty-five, and these therefore would have a very good chance of reaching maturity. The most important factor, however, is migration. It would be expected that arrivals from outside would be more likely to become settled successfully on the sprayed leaves where there is ample room than on the already heavily-infested unsprayed ones. The following counts made when breeding had ceased show the actual degree of control—

Average number of living scales per leaf on sprayed trees..	11·3
Average number of living scales per leaf on unsprayed trees	17·8

The drop in average in both cases is due to natural mortality together with the fact that a new growth of leaves had been produced. From the figures it will be seen that there has been a lasting control of about 37 per cent. from a kill estimated at 98 per cent. The actual kill was probably greater than that, since migration had no doubt occurred prior to the counting.

It is obvious from these experiments that in any test there must be a differentiation between lethal effect of the spray and control value of the spraying, and the importance of time of application is made very clear.

[TO BE CONTINUED.]

The Animal Parasites of Domesticated Animals and their Control.

By F. H. S. ROBERTS, M.Sc., Entomologist, Animal Health Station, Yeerongpilly.

PARASITISM occurs in both the plant and animal kingdoms, and may be regarded as a type of existence in which one organism—the parasite—is wholly or partly dependent upon another organism—the host—for food and, sometimes, shelter.

Of the many animals whose mode of life might possibly be included under this definition a good number are predaceous, and it is therefore necessary to distinguish between those which are predaceous and those which are parasitic. The demarkation between these two types of existence is at times ill defined, but it may be said that the predaceous animal lives free and, by means of the special cunning and prowess with which it is equipped, is able to snare and capture its prey; whereas the true parasite, in the lazy existence it leads, has no need of these special senses so highly developed in the predaceous animal. Those animals which are predaceous, moreover, devour their prey either whole or piecemeal. The parasite, on the other hand, as a rule, cannot exist once its host is destroyed, and its relations with the host are such that in order to obtain food and shelter from the host its endeavour is to keep the host alive. The praying mantis which captures and feeds on other insects is predaceous, while the various species of lice are parasitic.

Almost every group in the animal kingdom contains species which are parasitic. The range of parasitism extends from associations between host and parasite, in which the parasite may not only do no harm to the host but even at times give certain benefits in return for the food and shelter provided, to associations in which the parasite is distinctly injurious. This latter may be considered as true parasitism.

Such parasites may visit the host only at such times as they require food, and are known as temporary parasites. Bed bugs, fowl ticks, march flies, and mosquitoes are all temporary parasites. Others are dependent on the host not only for food but also for shelter, and are called permanent parasites, such as lice, the sheep ked, the spider or louse flies, and the various species of parasitic worms.

A convenient classification of parasitic animals may be made, depending on whether the parasite exists on the body surface or inside the body. Those found on the body are called external parasites, in contradistinction to which those feeding inside the body are known as internal parasites. Lice, biting flies, &c. are all external parasites while bots and worms are examples of internal parasites.

EXTERNAL PARASITES.

External parasites are all arthropods, or animals possessing six or eight legs. Only a few species of this group are parasitic, however, and, so far as the domesticated animals are concerned, only the *Insecta*, which contains the insects and the *Arachnida*, in which the ticks and mites occur, contain species which are associated with a parasitic life.

INSECTS.

An insect may be readily recognised by the three pairs of legs and by the division of the body into a distinct head, thorax, and abdomen.

The head usually bears a pair of antennæ. The thorax always possesses three pairs of legs and, in most cases, one or two pairs of wings.

With the exception of the bot flies, parasitic insects are external parasites. The parasitic species are confined to the three orders, *Diptera* or true flies, *Anoplcura* or lice, and *Siphonaptera* or fleas.

True Flies.

True flies have only one pair of wings, the second pair found in other orders of insects being represented by a pair of rudimentary structures—the balancers. In some parasitic forms the wings may be entirely wanting. The mouthparts are constructed to form a sucking tube which in the parasitic species is modified for piercing purposes as well, enabling the insect to penetrate the skin of the host and suck up the blood and fluids.

The parasitic members of this order include mosquitoes, sandflies, march flies, the stable fly, the buffalo fly, and the spider or louse flies.

Lice.

These are generally small, flattened insects, always without wings, and with some or all of the legs provided with claws. All the members of this order are parasitic in habit.

Lice are divided into two groups—the biting lice (*Mallophaga*) and the sucking lice (*Siphunculata*).

Biting lice have a broad, flattened head which is usually wider than the thorax. The mouthparts are located on the under side of the head and are constructed for biting and chewing only. Biting lice feed on the hair, scales, skin, and feathers, or on such scabby or scurfy material as occurs among the hair or feathers of the host. They do not suck blood or live on blood in any way except when it occurs on the skin surface through the host biting or scratching itself. Biting lice are most usually to be found on birds, though nearly all domesticated animals harbour some species.

Sucking lice are usually larger than biting lice, and the head is elongate and pointed. In this sub-order the mouthparts are of the piercing and sucking type, and the louse lives on the blood and fluids of the host. Sucking lice are found on mammals only, and are not known to occur among birds.

Fleas.

The members of this order have the body compressed laterally, and are usually very small in size and dark brown in colour. The mouthparts are adapted for piercing and sucking, and the insect lives on blood. There are no wings. The legs are well developed, especially the posterior pair, which are long, powerful, and adapted for leaping which is the normal mode of progression among these insects.

The adult flea spends most of its lifetime upon the host, but the other stages in the life cycle occur off the host and usually in the soil or other suitable places.

The Life Cycle of Parasitic Insects.

Among the parasitic insects two distinct types of life cycles are observed. In the case of lice the female glues her egg to the hair or

feathers of the host. In time this egg hatches to give rise to a tiny louse not unlike the parent in general appearance but much smaller in size and not sexually mature. After feeding for some time the small louse casts its skin, and the second phase in the life cycle is reached. This is larger in size and more like the adult in appearance. Further moults or skin castings take place, and eventually the sexually mature adult appears.

With the flies and fleas, on the other hand, the egg hatches and a small elongate segmented larva appears. This stage feeds and grows and, in time, forms the "pupa" which may lie motionless in the soil or be actively swimming, as in the case of mosquitoes. When the larva is fully grown it shrinks and the outer larval skin hardens and usually turns brown. In this pupa the larval tissues are broken down and reformed to produce the adult fly which, in time, emerges and commences its life. Thus there are four stages, each of which is entirely different to the others, namely, the egg, larva, pupa, and adult.

ARACHNIDA.

This group includes, besides the mites and ticks, the spiders and scorpions as well. They are distinguished from insects by the adult's four pairs of legs, the insect having only three pairs. In the spiders and scorpions the body is divided into two distinct portions one of which is the abdomen. The other division is known as the cephalothorax, and is formed by the fusion of the head and thorax.

In the mites and ticks the head, thorax, and abdomen are so fused together that there is no distinct division of any sort. It is only these two groups which contain parasitic species.

Ticks.

All ticks are parasitic and are to be found on a very wide range of animals. In general these are flattened and oval in appearance, and on engorgment with blood may attain a very conspicuous size. The mouthparts are usually placed at the narrower and anterior end, and consist of a pair of mandibles which enable the tick to pierce the skin of the host. Once the skin is pierced a club-shaped structure with rows of recurved teeth is then inserted. This maintains the tick in position and allows it to hang free on the body. Ticks suck blood, preventing its coagulation by injecting an anti-coagulating fluid into the wound.

The life cycle of the tick is very similar to that of the louse in that a series of moults are required before the adult stage is reached. The eggs are always laid in some sheltered spot on the ground. The young tick that emerges is peculiar in having only three pairs of legs in comparison to the adult's four pairs. The larva, on finding its host, engorges and then moults to form the nymph. This stage then, in turn, engorges and moults, sometimes to give rise to a further nymphal stage, but more usually to the adult. The moults may occur on the ground or on the host, in the former case, the new phase finding a new host in the manner of the larva.

Mites.

The great majority of mites are free living. Many species are injurious to economic plants; some are predaceous and the number parasitic on animals is comparatively small. These parasitic species are

very minute in size, the largest of them being no bigger than a pin's head. They differ from ticks in many ways, but are readily recognised by their small size and the absence of the holdfast structure with its recurved teeth so characteristic of ticks. Some species live on the surface of the skin, others beneath the skin, in most cases a mange condition arising as a result of the irritation.

Here, also, there are egg, larval, nymphal, and adult stages, as in the case of ticks, but with few exceptions the whole life cycle is spent on the host. Some species—our scrub-itch mites, for example—are parasitic only in the six-legged larval stage, the remaining stages in the life cycle being generally predaceous.

INTERNAL PARASITES.

With the exception of the bot flies, whose larvæ are found in the nasal cavities of sheep, in the stomach of horses, and, in other countries under the skin of cattle, internal parasites consist almost entirely of worms, or *Helminths*. These may be readily divided into Flatworms and Roundworms, the Flatworms comprising the flukes and tapeworms.

FLUKES.

The flukes, or *Trematoda*, are generally flattened, leaflike, or sometimes conical worms. Suckers are always present, but vary in size and position according to the species. At the anterior end is the mouth which is surrounded by the oral sucker. There is a modified digestive system present, but rather peculiarly there is no anal opening. With few exceptions flukes are true hermaphrodites, and each individual may contain a complete set of both male and female genital organs. Flukes may occur in the alimentary canal, liver, lungs, and various other parts of the body.

Life History of Flukes.

The eggs reach the exterior in the body excretions—usually the dung. Here, under suitable conditions, they hatch into a small motile organism which must then bore its way into a snail before any further development can take place. After some time spent in the snail it is usually then ready to infect its host and, breaking out from the snail, reaches the open and is swallowed by the host in food or water. The snail is known as the intermediate host. In some species a second intermediate host is required.

TAPEWORMS.

Tapeworms, or *Cestodes*, as their popular name implies, are like a piece of tape in appearance, being elongate and flat. The body consists of a chain of segments which becomes very narrow towards the anterior end, which bears the very small head. Some species may attain a length of 25 feet or more, and others are so small as to be seen with difficulty with the naked eye. The head is usually provided with suckers, and is sometimes furnished with hooks, both of which enable the worm to attach itself to the wall of the intestine. There is no digestive system in the sense of a mouth, intestine, &c., the food being absorbed by the body surface. Each segment is an entirely separate identity so far as its sexual life is concerned, being provided with both male and female organs. Tapeworms usually occur in the intestine, and only a very few species are found in other parts of the body.

Life History of Tapeworms.

Of the many hundreds of species of tapeworms that have been recorded from different hosts, the life histories of very few are completely known. In all these instances, with only a single exception, an intermediate host is required to complete the life cycle. As an example, the life history of the hydatid tapeworm may be considered. The adult hydatid tapeworm is found only in the small intestine of the dog and other closely related animals such as the wolf. The dog is known as the primary host. The eggs of this adult tapeworm reach the exterior in the fæces of the dog, and in some way or other are swallowed by man, sheep, cattle, &c., all of which are intermediate hosts. The egg hatches in these intermediate hosts and gives rise to a tiny larva which then makes its way to various parts of the body, usually the liver or lungs. In these organs it then develops into a bladder-like object containing fluid. This is the larval tapeworm. No further changes take place in the intermediate host, but if organs containing these bladders are fed to the dog the adult tapeworms eventually appear in the small intestine. In this case it has been shown that many animals may act as suitable intermediate hosts but, with other tapeworms, the intermediate host range may be limited to one or very few—the beef tapeworm of man, for example, has only one intermediate host, the larval stage being found in cattle.

ROUNDWORMS.

Roundworms, or *Nematoda*, are elongate and round. There is a mouth and intestine, and the sexes are usually separate, there being male and female worms. Of the many thousands of roundworms known the majority are free living; some species do serious damage to plants and others are parasitic in animals.

Life History of Roundworms.

Like flukes and tapeworms, roundworms cannot multiply and increase inside the body, and their numbers in a host can only be augmented by the host taking in the infective stage which occurs outside the animal.

The female roundworm produces eggs or larvæ which reach the exterior principally in the fæces. Under suitable conditions the egg may develop into an infective stage, when it contains a tiny worm, or the egg may hatch outside the body, and the larva, after a certain period of development becomes infective. The infective stage, whether egg or larva, on gaining access to a suitable host, grows to the adult stage. In other cases an intermediate host is necessary, the egg or larva in the dung being eaten by a beetle or a fly or some other small animal, the adult form being reached only when the beetle, &c., is eaten by a suitable host.

THE HOST RANGE OF PARASITES.

In the case of such temporary parasites as march flies, mosquitoes, sand flies, &c., a large number of different kinds of animals act as suitable hosts. The various species of ticks usually favour one kind of animal on which they find conditions most suitable for their development, but may occasionally attack and live on other animals. The majority of the many kinds of ticks usually get their popular name from the animal on which they most frequently are seen. Thus we have the cattle tick, the dog tick, the kangaroo tick, &c. But the cattle tick sometimes occurs

on horses, sheep, and dogs, and the dog tick on cattle and cats, and so on.

Mites and lice, however, appear more restricted, and, as a rule, can exist and increase only on the one species of host. The various mange mites may transfer themselves from one species of animal to another and, although they may live for some little time on the second animal, do not succeed in establishing themselves. Similarly, with perhaps only one or a very few exceptions, the lice that occur on one animal are never found infesting a different species of animal.

In the case of worms it may be said that unless the animals are closely related species it is unusual, under natural conditions, to find the worms of one host species occurring in another. The worms found in sheep, for example, are frequently observed in cattle and goats, but do not infest horses or pigs. Poultry worms are restricted to poultry, and probably some of the species of wild birds, and never occur in pigs, &c. Similarly, it is most unlikely that our marsupials would play any great part as hosts and distributors of the worm parasites of any of our domesticated animals.

THE ECONOMIC IMPORTANCE OF PARASITES.

Generally speaking a few parasites cause little harm to the host, but when the infestation is heavy serious disturbances to the health of the host may result.

External parasites pester and irritate. They may not only considerably weaken the host through the loss of blood, but their presence results in a loss of nervous energy with a consequent interference with nutrition. Heavily infested animals will not fatten, and young animals may remain stunted.

External parasites are also important as vectors or carriers of the organisms of serious diseases. The fowl tick, for example, may transmit fowl tick fever, and the cattle tick cattle tick fever. Mosquitoes carry malaria and fleas carry bubonic plague. Others act as intermediate hosts for harmful worm parasites, one of the best examples being the mosquito which carries the larvæ of *Waucheria bancrofti,* the cause of filariasis in man.

The effect of internal parasites upon the host depends not only upon the numbers present but also upon the tissues infested and the habits of the species. Those species lying free in the alimentary canal are, comparatively speaking, the least harmful. These may rob the host of food, cause mechanical obstructions, and irritate the lining of the stomach and intestines. Blood-sucking species are distinctly harmful, and may produce an acute anæmic condition. Then there are species which invade and destroy tissues vital to the host's wellbeing, resulting in a stunted and unthrifty animal. All worms, moreover, are considered to produce toxins which are highly poisonous substances and which may be absorbed into the host's body with serious effects.

THE CONTROL OF PARASITIC INFESTATIONS.

The control of any parasitic disease involves three distinct steps—

(1) A knowledge of the various symptoms of parasite presence and of the species of parasite concerned;

(2) The application of an efficient method of treatment; and

(3) The adoption of certain measures to prevent reinfestation or to keep it below the point at which it becomes harmful.

(1.) Parasitic infestation is usually associated with certain symptoms which, however, do not as a rule become prominent until the infestation has become serious. These symptoms are dealt with in detail under the several species of parasites described herein.

Suspecting parasite presence from the symptoms manifested, the stockowner must now take steps to find out which species of parasite is concerned. This is important, because without such an examination an efficient treatment cannot be given. In the case of such external parasites as lice, fleas, and ticks, an examination of the skin surface makes the cause of the irritation at once apparent. With mange diseases, on the other hand, it is necessary to have skin scrapings examined at a laboratory, not only for a correct diagnosis of the disease condition, as skin diseases similar to mange in appearance are not always caused by mange mites, but also in order to obtain a correct identification of the species of mite, as the treatment depends largely on the species of mite causing the disease. Similarly, with the red mite and feather mite of poultry, a correct identification is essential for efficient treatment, for fowls infested with feather mites must be dipped, whereas red mite control does not require such treatment.

In the case of worms, also, a determination of the species causing the outbreak is necessary, for drugs which will remove hookworms, for example, are not effective against tapeworms. The method of diagnosis depends largely upon the number and value of the animals infested. With animals of relatively small value one or two of those showing pronounced symptoms should be killed and a careful examination made of all the internal organs and tissues, paying particular attention to the stomach, small intestine, large intestine and blind gut, liver, and lungs.

Should the stockowner not wish to sacrifice any animal for such an examination, he may be able to secure specimens of the parasite by carefully watching the dung, in which worms in cases of heavy infestation are sometimes passed in numbers. He may also avail himself of the assistance given by the laboratory, where by an examination of a sample of dung or other excretions the eggs or larvæ of the parasite may be detected.

It is always advisable to send in all specimens of external or internal parasites to the laboratory for a correct identification. This not only ensures that the treatment will be the most efficient available, but it is also of great assistance in enabling the laboratory worker to obtain very necessary information on the distribution, prevalence, &c., of any parasite.

(2.) For external parasite control various liquids, powders, and oils are available. For lice and ticks of cattle, horses, and sheep an arsenic solution is applied, usually in the form of a dip, though when only a relatively few animals are to be treated the solution may be used as a spray. For lice and fleas on small animals powders such as pyrethrum and sodium fluoride are suitable. Mange conditions and isolated confined lice infestations may be held in check by oils. Oils also usually form the base of repellents for lessening the severity of sandfly or march fly attack.

If carefully carried out one treatment may be depended upon to kill most if not all the parasites, but is usually not so effective against the egg. For the best results, therefore, at least two treatments are necessary. The second treatment should be delayed long enough to give these eggs sufficient time to hatch, but the interval must be such that no opportunity is given any parasite hatching from these unaffected eggs to reach maturity and lay further eggs.

For the removal of internal parasites various drugs are available which may be administered either in liquid form or in capsules. These drugs are all poisons and great care should be given their use. No more than the recommended dose should be given, and, to avoid any possibility of mistakes in mixing or dosing, a few animals should be treated a few days before the flock or herd and carefully watched for any ill results.

There is no drug known which can be depended upon to remove all worms after a single dosing. At least two treatments should be given after an interval sufficient to permit the animal to recover completely from the first. Where the infestation is heavy and continuous full advantage of even a highly effective drug only follows many treatments made at regular intervals throughout the year.

Individual treatment will always give best results, and attempted administration of remedies in food, drinking water, and licks is not advised unless in exceptional circumstances. The treatment of every member of a flock of poultry, for example, is regarded in many quarters as costly and impracticable, and here mass treatment by means of drugs in the food is frequently recommended.

Starvation for some time before the drug is administered is usually necessary. This allows better contact of the drug with the worm which would otherwise be protected to a large extent by the partly digested food.

(3.) Treatment is of little value, no matter how effective, so long as the animal can readily become reinfested. In the case of the worm parasites, it has already been pointed out that these cannot breed and increase inside the animal, and that the only way in which an animal can become infested is from the soil, water, or some intermediate host infected with a phase in the life history spent outside the animal. As this external phase originates in the body excretions, usually in the dung, worm parasite control can only be accomplished by cleanliness and sanitation. This is especially desirable in the case of such closely confined animals as poultry, pigs, and horses. As a rule, also, the free-living stages cannot develop in the absence of moisture. Therefore, regular removal of all dung, dry, clean conditions, and the adoption of measures to keep all food off the contaminated ground are essentials for worm parasite control.

Where animals such as sheep and cattle are concerned the draining and rotation of pastures and burning-off at certain times of the year is advisable.

Another control measure which may sometimes be adopted is the spelling of land for such a period that the free-living stages will have all succumbed.

When it is pointed out that efficient drugs are known only for a comparatively few species of the many worms that occur in domesticated

animals preventive measures assume an extremely important position, and the stock owner should take every step to see that they are observed so far as practicable.

Sanitation is also necessary for external parasite control, for not only is it concerned with the breeding places of such pests as fleas and mosquitoes but it also prevents to a certain degree the spread of lice and mites.

As young animals are more readily affected by parasite presence than old animals special care should be taken in the application of any measure which will prevent infestation to any extent. They should always be kept away as much as possible from the older animals and the contaminated ground on which these have been running.

Finally, it may be said that as nutrition probably plays an important part in the ability of the animal to resist the effects of infestation some thought should be given this phase of control. It has been found, for example, that in the case of sheep top-dressing of the pastures and the provision of suitable licks will enable the sheep to resist worm infestation to a conspicuous extent.

QUEENSLAND SHOW DATES, 1934.

July.

Bowen, 4th and 5th
Gatton, 4th and 5th
Kilcoy, 5th and 6th
Ayr, 6th and 7th
Townsville, 10th to 12th
Woodford, 12th and 13th (Sports only)
Rosewood, 13th and 14th
Cleveland, 13th and 14th
Cairns, 17th to 19th
Charters Towers, 18th and 19th
Caboolture, 20th
Barcaldine, 24th and 25th
Nambour, 18th and 19th
Atherton, 24th and 25th
Esk, 27th and 28th
Pine Rivers, 27th and 28th

August.

Royal National, 6th to 11th
Home Hill, 31st August and 1st September

September.

Enoggera, 1st
Imbil, 7th and 8th
Ingham, 7th and 8th
Pomona, 12th and 13th
Innisfail, 14th and 15th
Mareeba, 20th and 21st
Beenleigh, 20th and 21st
Rocklea, 22nd
Malanda, 26th and 27th
Kenilworth, 29th

October.

Southport, 5th
Millaa Millaa, 5th and 6th
Tully, 12th and 13th

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The Determination of Larval Instars and Stadia of Some Wireworms (Elateridæ).

By W. A. McDOUGALL, Assistant Entomologist.

SOME three years ago the writer visited Mackay in order to undertake a comprehensive investigation of the wireworm pests of sugar-cane in Central Queensland. This investigation had not proceeded far before it was realised that it was necessary to have more exact information than was available on methods of determining the larval instars of wireworms, as a means to determining, in turn, the larval stadia. Considerable attention was accordingly given to this work. In the course of the past three years, over thirty different species of Elaterid larvæ have been collected in the area embraced by the investigation. Of these species, one was taken from the rotted wood on the damp lee-side of a tree stump, another from under bark, but the remainder were soil inhabitants. The wood-inhabiting species, and three of the soil species, were of the brown cylindrical type of larva with the ninth abdominal segment either simply rounded at the apex or gradually tapering to a point. Of the remaining species, all were of the yellowish semi-flattened Elaterid larval type with specifically shaped ninth abdominal segments with processes. Included in this latter group is *Lacon variabilis* Cand.; as this species is considered (9) to be the most serious wireworm pest of sugar-cane in the areas mentioned, its life cycle and habits have been observed in as much detail as possible. At the same time, the methods employed in the study of its life cycle and habits have been applied to those of other Elateridæ (mainly, but not exclusively, species of the same larval type that inhabit cultivated fields) for the purpose of checking the reliability of these methods, and also for comparing and contrasting the larval periods and general behaviour of these species with *L. variabilis*.

A. HISTORICAL.

Although the larvæ of a number of Elateridæ of economic importance have been studied, there are few published accounts of a detailed nature dealing with the length of the complete larval period or with larval instars and their stadia. Many of the workers, such as Graf (6) and Ford (5), have had to deal with pest species of wireworms which evidently require two to five or more years from egg to pupation, according to the particular species. The lengths of the larval periods have usually been estimated from observations, chiefly on the sizes of the larvæ found in the field at different times of the year, and the observed rates of growth of some of the different sized larvæ in captivity. The number of larval instars of any species has never been accurately ascertained, and very few species have been taken through from egg stage to adult.

From a survey of literature relevant to this phase of "wireworm" work, it appears that larval length is the usual criterion upon which the larvæ of any species are differentiated into groups, and this grouping is as far as most investigators have proceeded. Ford (5), after working with *Agriotes obscurus* Linnaeus, stated that many of the smaller stages

taken in one year, from July to October, varied much in size, and it was found that after about two months a number of these apparently small specimens were really of medium size. It therefore appeared to him that the breadth might be a safer criterion of age than length. Graf (6), although not successful in working out the number of larval instars of *Limonius californicus* Mannh. on account of the unsuitability of the available rearing apparatus, found the increase in the width of the head to be the best indication of an ecdysis.

Various authors have made observations on the growth rates of some species of Elaterid larvæ at different stages during larval life. Graf (6) found there were indications that *L. californicus* moulted five or six times during a larval life calculated to extend a trifle over three years. Larvæ grew rapidly during the first two or three weeks after emerging from the eggs, but this was the only time during their long larval period when growth was apparent. To Veitch (17), the moults of *Simodactylus cinnamoneus* Boisd. appeared to be of frequent occurrence and, in the older wireworms in the laboratory, they might be expected to occur once every eight to twelve weeks. The complete larval life was considered to extend over two or three years: growth rate of the young wireworms was found to be very slow. Ford (5) thought the larvæ of *Agriotes obscurus* passed through three stages, limited by three moults, and were full grown at the end of three years. There is then a period of active feeding, followed by a quiescent condition and terminating in pupation; total length of larval period was computed at four years. The rate of growth was found to be so uniform as to suggest that the curve of growth would be fairly continuous rather than irregular. Roberts (15) found *Agriotes* spp. to moult twice a year, and the rate of growth of the first stage larvæ to be very slow. The earlier estimate of five years for the larval stage of *A. obscurus* is considered to be approximately correct. Mesnil (11), who studied a number of wireworms in France, found that all seemed to have lengthy larval stages, and the larval period of *A. sputator* L. was calculated to be three years. The growth rate of the earlier instars was found to be extremely slow. Fenton (4) found that the growth of two species of *Melanotus* was very slow during the first year of larval life and that, during that time, one moult took place. Conradi and Eagerton (3) give the average periods occupied by the different stages of *Monocrepidius vespertinus* Fab. as twelve days for the egg, 305 for the larval, and thirteen for the pupal stages. In Hawaii (16) *Monocrepidius exsul* is thought to have a larval period of one year or more. Unfortunately no references are made to the growth rates of any of the larval instars of these two *Monocrepidius* species.

B. DETERMINING LARVAL INSTARS.

Various possible criteria for the grouping of larvæ of *Lacon variabilis* were investigated during the course of the rearing work with a view to enabling definite determination of instars. These included the following:—

1. Length of larvæ.
2. Greatest width of ventral mouth parts.
3. Antennal segment ratios, and other mouth part measurements.
4. Width of head capsule.

5. Time of feeding of an instar.
6. Appearance of an instar prior to an ecdysis.
7. A peculiarity in the shape of the first instar.

The results which were obtained are discussed under these headings, and this is followed by a brief discussion of Dyar's Law in its application to the larvæ of *L. variabilis*. A short account is also given of similar work which was carried out to some extent with the other species found.

During the last three quarters of 1931 approximately 1,200 larval specimens of *L. variabilis* were taken from cane fields; of these 306 were used for rearing purposes, and 219 adults were obtained from them between October and the end of that year.

Length of Larvæ.

Numerous measurements of length were taken at monthly intervals during the rearing of the larvæ (Table I.), but apart from serving as a general guide to the probable stage of development they were of little value. The chief result accruing from this rearing work was the correlation of the larva with its correct adult. After length measurements had failed to provide a method for the working out of the details of the larval life with the degree of precision desired, further search was made for criteria suitable for the purpose, as outlined.

Greatest Width of Ventral Mouth Parts.

The ventral portion of the mouth parts of an Elaterid larva is a conspicuous structure situated in a large depression on the venter of the head Plate 1, figs. A and B).

This structure is formed by the fusion of the stipites of the maxillæ with the mentum (Plate 1, fig. E [a]). In some genera (e.g., B. sp.) the mentum is quadrilateral and much longer than wide; in these instances more of the cardines are visible when the whole of the ventral mouth parts is retracted than is so with *Lacon* spp. and *Heteroderes* spp., each of these possessing a triangular mentum. A total of 229 larvæ of different sizes was examined, and it was found that these could be grouped according to the greatest width of the ventral mouth parts, i.e., the measurement (A-B) illustrated in fig. A of Plate 1. In a number of instances this grouping (Table II.) disagreed with the grouping as obtained when the same larvæ were separated on the basis of length. The groups obtained by this means were well defined, there being no individuals with intermediate measurements which might equally well be placed in two groups. During 1931 several larvæ, which had just shed their skins, had been preserved with the exuviæ which had been found near them. The (A-B) [b] measurements of the mouth parts of these larvæ and their respective exuviæ were taken, in the manner described above. Each exuvium measurement was within the limits of the group immediately preceding that into which a similar measurement of the correctly-related larva fell.

(*a*) This drawing represents one section of a complete serial section of a sixth instar. The block was prepared by the double embedding in celloidin and paraffin (adapted from Guyer: Animal Micrology, Revised Edition, p. 64) of the instar immediately after ecdysis; the larva was completely white with the exception of the tips of the mandibles, which were brown.

(*b*) For the sake of convenience the greatest width of the ventral mouth parts is termed the (A-B) measurement both in the text and tables.

TABLE I.

LENGTHS OF LARVÆ IN CENTIMETRES; DATA BASED ON THE RECORDED OBSERVATIONS ON 306 LARVÆ AND 3 PUPÆ, MADE DURING REARING WORK, 1931.

Lab. No. of Larva and Pupa.	DATES OF OBSERVATIONS.										
	14th May	8th June	22nd June.	6th July.	5th Aug.	9th Sept.	28th Sept.	Oct.	Nov.	Dec.	Jan. (1932).
P. 2 ..	P.f.		Adult 19th May.								
L. 2 ..	Length ·58 cm.	p.n.c. n.e.	p.n.c. n.e.	p.n.c. n.e.	p.n.c. n.e.	e. Ex. f. ·9 cm.	e. Ex. f. 1·2 cm.	..	Adult (17th)	..	..
L. 19 ..	1·45	p.n.c. n.e.	1·7	e.h. 1·6	n.e. 1·7	e.h. 1·9	n.e.	n.e.	P.f. (17th) Adult (29th)	..	..
L. 23 ..	1·1	p.n.c. n.e.	p.n.c. n.e.	p.n.c. n.e.	n.e. Ex. f. 1·1	e.h.	e.h. Ex. f. 1·5	n.e. 1·7	P.f. (17th) Adult (24th)	..	..
L. 31 ..	1·0	n.e. Ex. f. 1·4	p.n.c. e.h.	n.e.	n.e.	e.h. Ex. f. 1·5	n.e.	n.e.	P. f. (17th) Adult (30th)	..	..
L. 40 ..	1·5	e.h. 1·6	p.n.c. n.e. 1·74	p.n.c. n.e.	p.n.c. n.e.	p.n.c. n.e.	p.n.c. n.e.	P.f. (12th) Adult (21st)	..	..	..
L. 47 ..	1·9	p.n.c. e.h. ..	p.n.c. n.e.	p.n.c. n.e.	Just changed Ex. f.	e.v.h. 1·86	e.h. Ex. f. 1·94	..	P. f. (17th) Adult (22nd)	..	..
L. 52 ..	1·1 ..	p.n.c. n.e.	p.n.c. n.e.	..	p.n.c. n.e. 1·1	e.v.h. 1·4	p.n.c. 1·5	e.h. Ex. f. 1·7	P.f. (17th) Adult (21st)	..	..
L 70 ..	·77	e.	..	..	Ex.f.	e.h. 1·2	e.h. 1·3	e.h. 1·6	p.n.c. n.e.	P.f. (27th)	Adult (8th)
L. 81 ..	1·9	e.v.h. Ex.f.	n.e. p.n.c. 1·9	p.n.c. n.e.	p.n.c. n.e.	p.n.c. n.e.	In a cell	P.f. (12th) Adult (17th)	..	..	..
L. 87 ..	·83	h.e. Ex.f. 1·0	p.n.c. n.e.	n.e.	n.e.	e.v.h. 1·6	1·7	e.v.h.	P.f. (17th) Adult (29th)	..	..

L. 88 ..	1·9	Just changed Ex.f.	e.v.h. 1·9	n.e.	n.e.	n.e.	n.e.	1·8	..	P.f. (5th) Adult (10th)	..
L. 98 ..	1·7	e.v.h. Ex.f. 1·9	1·9	n.e.	Just changed n.e. Ex.f.	e.v.h.	2·0	..	P.f. 2nd Adult (15th)	..	..
L. 120 ..	Taken from field 27th May 1·6	..	e.v.h. Ex.f. 1·6	1·9	..	Nearing an ecdysis	e.v.h. 1·9	..	..	P.f. (3rd) Adult (8th)	..
Ls. 140 to 145		..	.. ..	Taken 10th July 1·7	p.n.c. n.e.	.. ..	..	1·6 to 1·7	..	P.f. (17th) Adults (20th to 25th)	..
L. 152 ..	..	..	..	1·3	Ex.f. 1·5	e.v.h.	Ex.f. 1·6	e.v.h.	..	P.f. (10th) Adult (21st)	..
L. 161 ..	..	..	..	1·9	p.n.c. n.e.	p.n.c. n.e.	p.n.c. n.e.	p.n.c. n.e.	P.f. (2nd Adult (10th)	..	..
L. 205 ..	.. ..	..	..	1·9	p.n.c. n.e.	e.v.h. Ex.f. 2·0	..	..	P.f. (2nd) Adult (10th)	..	..
L. 230 ..	..	..	..	2·1	p.n.c. n.e.	p.n.c. n.e.	p.n.c. n.e.	..	Adult (17th)	..	..
L. 255 ..	..	..	..	Taken 27th July very small	e.h.	1·3	e.	e. 1·6	e.v.h. Ex.f. 1·6	e.v.h.	P.f. (8th) Adult (10th)
L. 256 ..	..	..	..	Very small	e.h.	1·0	e.	e.v.h. 1·45	e.v.h.	P.f. (18th) Adult (20th)	..
Ls. 295 to 301	..	..	..	..	..		..	Taken 14th Oct. 1·6—2·1	Adults (17th-28th)	..	..

p.n.c. = probably no change; n.e., e., e.h., e.v.h. = not eaten, eaten, eaten heavily, or eaten very heavily, of potato tuber since last inspection (fresh potato tuber supplied after every inspection). Ex.f. = exuvium found; P.f. = pupa found.

TABLE II.—MOUTH PART MEASUREMENTS OF SIX GROUPS OF LARVÆ.

Group.	Number of Larvae Measured.	GREATEST WIDTH OF VENTRAL MOUTH PARTS. (in mm.)		
		Minimum.	Mean.	Maximum.
A	5	·35	·38	·40
B	10	·47	·52	·54
C	68	·63	·68	·70
D	60	·79	·83	·86
E	29	·96	·99	1·03
F	57	1·12	1·15	1·24
Total	229	..	..	..

In December, 1931, and January, 1932, approximately 1,000 eggs of *L. variabilis* were obtained from adults bred from larvæ during 1931 and from other adults collected in the field. From these eggs many larvæ emerged and were used for rearing purposes. With the rearing apparatus in use at that time the majority of the exuviæ from the younger instars could not be recovered from the soil in the rearing jars. However, the (A-B) measurements of 179 small instars were taken; at the time of measurement some of those larvæ had just emerged from eggs. Again, grouping could be effected, and the details are given in Table III.; obviously groups J and K contain larvæ similar to those represented by groups A and B respectively of Table II. It would seem, therefore, that any larva of *L. variabilis* can be placed, according to its (A-B) measurement, into one of eight groups.

TABLE III.—MOUTH PART MEASUREMENTS OF FOUR GROUPS OF LARVÆ.

Group.	Number of Larvae Measured.	GREATEST WIDTH OF VENTRAL MOUTH PARTS. (in mm.)		
		Minimum.	Mean.	Maximum.
G	89	·161	·163	·167
H	50	·21	·23	·28
J	27	·35	·38	·40
K	13	·47	·53	·54
Total	179	..	..	..

The percentage loss by death in rearing young larvæ up to the fourth group (Group K of Table III.) was exceptionally heavy during 1932. Varying environmental conditions were tried, and when a suitable set of conditions was found, 134 larvæ were reared from eggs to

TABLE IV.

(A–B) MEASUREMENTS AS DETERMINED FROM THE RECORDED OBSERVATIONS OF 134 LARVÆ.

Laboratory No. of Larva.	Egg Laid.	First Instar.		Remarks on any Intermediate (A–B) Measurements and Ecdyses.	Ecdyses Observed.													Date of Appearance of Adult.	Length of Complete Larval Period (in days).
		Date of Emergence.	(A–B) Measurement.		Date.*	(A–B) Measurement of Exuvium.	(A–B) Measurement of Larva.	Date.*	(A–B) Measurement of Exuvium.	(A–B) Measurement of Larva.	Date.*	(A–B) Measurement of Exuvium.	(A–B) Measurement of Larva.	Date.*	(A–B) Measurement of Exuvium.	(A–B) Measurement of Larva.	Date.*	(A–B) Measurement of Exuvium.		
L1. 1	8 i.	16 i.	·163	Larvæ with (A–B) measurement of ·65 on 8 iii.	..	..	..	12 iii.	·65	·79	29 iv.	·79	·98	1 vi.	·98	1·14	1 x.	1·14	16 x.	259
L1. 3	8 i.	16 i.	·162	Larvæ with (A–B) measurement of ·54 on 16 ii.	20 ii.	·54	·67	8 iii.	·67	·84	1 v.	·84	1·03	21 vi.	1·03	1·24	30 x.	1·24	14 xi.	288
L1. 6	8 i.	16 i	·166	Found on 24 ii. an exuvium with (A–B) measurement of ·35; on 27 ii. (A–B) measurement of larvæ was ·47	2 iii.	·47	·63	10 iv.	·63	·79	25 v.	·79	·98	29 vii.	·98	1·20	1 xi.	1·2	16 xi.	290
L2. 2	10 i.	18 i.	·167	..	..	..	..	25 iv.	·65	·82	6 vi.	·81	·98	4 vii.	·98	1·16	23 xi.	1·16	7 xii.	310
L2. 3	10 i.	18 i.	·161	Larvæ with (A–B) measurement of ·53 on 18 ii. ..	19 ii.	·53	·67	4 iii.	·67	·84	15 iii.	·84 (Pupa)		..	..	..	..	..	29 iii.♂	57
L2. 5	10 i.	18 i.	·163	..	..	..	..	24 ii.	·65	·80	4 iii.	·81	·98	..	..	..	26 iii.	1·16	9 iv.♀	68
L2. A1	28 i.	6 ii.	·167	Two ecdyses recorded. (A–B) measurement 12 ii. (Ex. ·26) (L. 39); 28 iii. (Ex. ·39) (L. 51)	30 iv.	·51	·65	4 vi.	·66	·81	26 viii.	·81	·98	7 x.	·98	1·12	24 xi.	1·12	10 xii.	292
L2. 26	1 ii.	9 ii.	·161	Ecdyses recorded on 12 iii. (Ex. ·237) (L. ·373)	..	..	..	1 v.	·63	·82	1 vi.	·82	1·02	28 vii.	1·02	1·25	14 xi.	1·25	29 xi.	279
L22. 11	29 i.	7 ii.	·164	Larvæ with (A–B) measurement of ·51 on 28 iv.	5 v.	·51	·63	18 vi.	·63	·79	1 ix.	·79	·98	1 x.	·98	1·15	12 xii.	1·15	Found Adult, 8 ii. 1933	..
L22. 17	29 i.	7 ii.	·164	Larvæ with (A–B) measurement of ·51 on 8 iii.	20 iii.	·50	·65	10 v.	·65	·86	5 vi.	·86	1·03	20 vii.	1·03	1·20	9 i. 1933	1·20	24 i., 1933	337
L22. 18	29 i.	7 ii.	·165	Recorded an ecdysis on 20 iii. (Ex. ·25) (L. ·39)	24 i.	·51	·65	1 v.	·65	·84	1 vi.	·84	·98	30 vii.	·98	1·16	26 x.	1·16	10 xi.	262
L22. 22	30 i.	8 ii.	·163	Larvæ with (A–B) measurement of ·49 on 15 v.	25 v.	·49	·65	26 vi.	·65	·86	24 viii.	·86	·98	26 x.	·98	1·20	25 xi.	1·20	9 xii.	291
L22. 23	30 i.	8 ii.	·163	Larvæ with (A–B) measurement of ·49 on 1 v.	14 iv.	·49	·63	5 v.	·63	·81	6 vi.	·81	1·03	24 vii.	1·03	1·20	26 x.	1·20	9 xi.	261
L22. 26	8 ii.	16 ii.	·161	Larvæ with (A–B) measurement of ·65 on 29 iii.	..	..	..	5 iv.	·65	·82	24 v.	·82	1·03	1 vii.	1·03	1·17	28 x.	1·17	11 xi.	255
L7. A8	1 ii.	9 ii.	·161	Recorded the ecdysis (Ex. ·25) (L. ·37)	..	..	..	4 iii.	·67	·82	30 iv.	·82	·98	1 vii.	·98	1·14	14 xi.	1·14	30 xi.	279

L1. 1, L1. 3, and L1. 6 are larvæ from eggs of adult L1. L22 only, represents more than one female confined in the one cage.

* ±) 2 days; in many instances the date is exact.

TABLE V.

(A–B) Measurements in Millimetres as Determined from the Recorded Observations on 117 Larvæ.

Laboratory No. of Larvæ.	Ecdyses Recorded.																Date of Appearance of Adult.
	Date when Collected from Field.	(A–B) Measurement on Date of Collection.	Date.*	(A–B) Measurement of Exuvium.	(A–B) Measurement of Larva.	Date.*	(A–B) Measurement of Exuvium.	(A–B) Measurement of Larva.	Date.*	(A–B) Measurement of Exuvium.	(A–B) Measurement of Larva.	Date.*	(A–B) Measurement of Exuvium.	(A–B) Measurement of Larva.	Date.*	(A–B) Measurement of Exuvium.	Pupa.	
128	19 April	·96	..	..	..	..	..	..	..	..	..	15 May	·96	1·16	19 Dec.	1·16	..	..
169	19 April	1·17	..	..	..	..	..	..	..	..	..	..	..	..	10 May	1·17	..	25 May
132	19 April	·65	..	..	..	27 April	·65	·86	21 July	·86	1·03	21 Oct.	1·03	1·21	1 Dec.	1·21	..	17 Dec.
134	19 April	1·17	..	..	..	..	..	..	..	..	..	..	..	..	8 May	1·17	..	22 May
135	19 April	1·03	..	..	..	..	..	..	..	..	..	1 June	1·03	1·16	1 Nov.	1·16	..	16 Nov.
146	19 April	·51	25 April	·51	·70	15 May	·70	·86	1 June	·86	·98	1 July	·98	1·16	25 Oct.	1·16	..	9 Nov.
150	19 April	1·16	..	..	..	..	..	..	..	..	..	..	..	..	?	1·16	..	Found Adult, 2 June
158	19 April	·47	20 May	·47	·67	1 July	·67	·82	15 Sept.	·82	·98	15 Oct.	·98	1·15	28 Nov.	1·15	..	12 Dec.
169	24 May	·65	..	..	..	20 June	·65	·82	21 July	·82	1·00	20 Aug.	1·00	1·16	25 Oct.	1·16	..	10 Nov.
182	1 June	†·39	28 Aug.	·51	·65	12 Oct.	·65	·82	30 Oct.	·82	·98	14 Nov.	·98	1·15	28 Nov.	1·15	..	13 Dec.
183	10 June	·96	..	..	..	..	..	..	..	..	..	15 June	·96	1·14	14 Nov.	1·14	..	30 Nov.
184	22 June	1·00	..	..	..	..	..	..	..	..	..	24 June	1·00	1·26	25 Oct.	1·26	..	9 Nov.
185	22 June	1·15	..	..	..	..	..	..	..	..	..	..	..	..	5 Nov.	1·15	..	20 Nov.
186	22 June	·98	..	..	..	..	..	..	..	..	..	20 July	·98	1·16	14 Nov.	1·16	..	29 Nov.
187	22 June	·96	..	..	..	..	..	..	..	..	..	20 Aug.	·96	1·12	14 Nov.	1·12	..	28 Nov.
190	22 June	1·26	..	..	..	..	..	..	..	..	..	..	..	..	1 Oct.	1·26	..	16 Oct.
191	22 June	1·26	..	..	..	..	..	..	..	..	..	..	..	..	14 Nov.	1·26	..	28 Nov.
192	22 July	·81	..	..	..	..	..	..	1 Aug.	·81	·98	12 Oct.	·98	1·14	14 Nov.	1·14	..	29 Nov.
198	15 Aug.	·51	28 Aug.	·51	·68	15 Oct.	·68	·84	28 Nov	·84	(Pupa)	..	..	..	..	..	..	12 Dec.
199	15 Aug.	·67	..	..	..	15 Sept.	·67	·86	11 Oct.	·86	1·00	20 Nov.	1·00	1·19	12 Dec.	1·19	..	..

* (±) 2 days; in many instances the date is exact.

† Ecdysis recorded on 9 June, (A–B) measurement of exuvium being ·39 and that of larva ·51.

adults. Each larva was watched carefully, and the necessary measurements of both larva and exuvium were taken after all the later ecdyses (Table IV.). It now seems apparent that at least the last five larval instars of *L. variabilis* can be recognised by referring the measurements of the greatest widths of their ventral mouth parts to Table II. During this year (1932) larvæ in different stages were taken from the fields at intervals and reared to adults (Table V.). This was done mainly for two purposes—firstly, to obtain additional evidence along the lines utilised in Table IV.; and secondly, to compare the development of the larvæ reared in the laboratory, from eggs to adults, with those living under field conditions during various portions of their existence.

Between December, 1932, and November, 1933, with a better knowledge of the environmental conditions desired by the smaller instars, and with more suitable rearing apparatus, 107 larvæ were taken through from eggs to adults. In 49 instances a complete set of eight larval exuviæ for each specimen under observation was obtained and the larval and exuvial (A-B) measurements were recorded as in Table VIA. In other instances an occasional exuvium was missed out; however (A-B) measurements taken of all exuviæ found, and also of the related larvæ, were in accord with what would be expected after a study of the recorded observations of which a portion are set out in Table VIA. There now seems to be no doubt that there are normally eight instars in the larval life of *L. variabilis,* and that any larval specimen of this species can be given its correct "instar number" by referring the measurement, in millimetres, of the greatest width of its ventral mouth parts to the eight distinct groups of Tables II. and III.

As in previous years a small proportion of the larvæ behaved in a manner similar to No. L2.3. of Table IV., i.e., pupation was reached after less than eight larval moults, and in four instances a complete set of six larval exuviæ for each specimen was recovered. In each instance the (A-B) measurement of the final larval exuvium corresponded to that of a larva in its sixth instar. When there are only six instars during the life of a larva, any resulting adult is invariably a small male. As in 1932 observations were made on numerous specimens collected in the field; records of such are very similar to those recorded in Table V.

In compiling the tables for this article from records of observations on larvæ reared from eggs in the laboratory, no references have been made to those instances when only one or two ecdyses (with necessary measurements) were recorded of any larvæ which, for some reason or other, were not taken through to pupation. The inclusion of such records would easily double the "ecdysal" measurements similar to those of Tables IV.-VIA., and it would be merely added evidence in favour of the points which these tables already demonstrate.

Antennal Segment Ratios and Other Mouth Part Measurements.

Roberts (16), when describing the first larval instar of an *Agriotes* sp., points out that the third, or supplementary segment in an antenna is longer than the conical ventral process at the apex of the second, but that this difference is much less in the mature larvæ. At this stage it is also much longer in proportion to the whole antenna than in the older larvæ. When working with *L. variabilis* it was found to be very difficult to measure accurately the true lengths of the segments of the antennæ (see Plate 1, fig. D.). Each segment can be withdrawn,

TABLE VIA.

(A–B) MEASUREMENTS IN MILLIMETRES AS DETERMINED FROM THE RECORDED OBSERVATIONS ON 49 LARVÆ.

Laboratory No. of Larva.	Egg Laid.	First Instar.		Date.	(A–B) Measurement of Exuvium.	(A–B) Measurement of Larva.	Date.	(A–B) Measurement of Exuvium.	(A–B) Measurement of Larva.	Date.	(A–B) Measurement of Exuvium.	(A–B) Measurement of Larva.	Date.	(A–B) Measurement of Exuvium.	(A–B) Measurement of Larva.
		Date of Emergence.	(A–B) Measurement.												
4	20 Nov., 32	28 Nov., 32	·162	5 Dec., 32	·162	·233	19 Dec., 32	·23	·39	12 Jan., 33	·39	·52	11 Feb., 33	·52	·65
5	20 Nov., 32	28 Nov., 32	·162	6 Dec., 32	·162	·237	18 Dec., 32	·24	·38	15 Jan., 33	·38	·52	24 Jan., 33	·52	·66
12	5 Dec., 32	12 Dec., 32	·161	24 Dec., 32	·161	·233	13 Jan., 33	·234	·40	16 Feb., 33	·40	·54	3 Mar., 33	·54	·70
26	21 Nov., 32	28 Nov., 32	·167	4 Dec., 32	·167	·235	11 Dec., 32	·24	·39	19 Dec., 32	·39	·53	1 Jan., 33	·53	·69
30	8 Dec., 32	15 Dec., 32	·165	24 Dec., 32	·165	·233	3 Jan., 33	·23	·38	20 Jan., 33	·38	·52	3 Feb., 33	·52	·67
33	5 Dec., 32	13 Dec., 32	·163	24 Dec., 32	·163	·234	13 Jan., 33	·234	·36	4 Feb., 33	·36	·52	20 Feb., 33	·52	·68
35	5 Dec., 32	12 Dec., 32	·163	19 Dec., 32	·163	·236	26 Dec., 32	·236	·38	10 Jan., 33	·38	·52	15 Feb., 33	·52	·69
37	13 Dec., 32	21 Dec., 32	·163	3 Jan., 33	·163	·233	24 Jan., 33	·233	·37	4 Feb., 33	·37	·53	21 Feb., 33	·53	·68
39	3 Jan., 33	10 Jan., 33	·163	24 Jan., 33	·163	·234	4 Feb., 33	·235	·37	21 Feb., 33	·37	·51	23 Mar., 33	·51	·66
41	3 Dec., 32	12 Dec., 32	·163	19 Dec., 32	·163	·233	25 Jan., 33	·233	·39	14 Feb., 33	·39	·53	16 Mar., 33	·53	·67
62	5 Jan., 33	12 Jan., 33	·162	24 Jan., 33	·162	·235	13 Feb., 33	·235	·38	24 Feb., 33	·38	·53	9 Mar., 33	·53	·67

TABLE VIA.—*continued.*

(A–B) MEASUREMENTS IN MILLIMETRES AS DETERMINED FROM THE RECORDED OBSERVATIONS ON 49 LARVÆ—*continued.*

Laboratory No. of Larva.	Egg Laid.	Date.	(A–B) Measurement of Exuvium.	(A–B) Measurement of Larva.	Date.	(A–B) Measurement of Exuvium.	(A–B) Measurement of Larva.	Date.	(A–B) Measurement of Exuvium.	(A–B) Measurement of Larva.	Date.	(A–B) Measurement of Exuvium.	Pupa.	Date of Appearance of Adult.	Length of Complete Larval Period (in days).
4	20 Nov., 32	15 Mar. ..	·65	·82	7 May ..	·82	·98	27 May ..	·98	1·15	7 Nov. ..	1·15	..	21 Nov., 33	344
5	20 Nov., 32	18 Feb. ..	·66	·85	10 Apr. ..	·85	1·00	30 May ..	1·00	1·20	1 Nov. ..	1·20	..	15 Nov., 33	338
12	5 Dec., 32	3 Apr. ..	·69	·86	7 May ..	·86	1·00	15 June ..	1·00	1·16	10 Nov. ..	1·16	..	24 Nov., 33	333
26	21 Nov., 32	23 Jan. ..	·69	·84	4 Feb. ..	·84	·98	20 Mar. ..	·98	1·12	26 Apr. ..	1·12	..	11 May, 33	149
30	8 Dec., 32	1 Mar. ..	·67	·82	29 Mar. ..	·82	·98	11 May ..	·98	1·15	26 Oct. ..	1·15	..	7 Nov., 33	315
33	5 Dec., 32	16 Mar. ..	·68	·85	5 Apr. ..	·85	1·00	13 May ..	1·00	1·20	9 Nov. ..	1·20	..	23 Nov., 33	331
35	5 Dec., 32	12 Mar. ..	·69	·85	1 Apr. ..	·85	1·00	9 June ..	1·00	1·16	14 Nov. ..	1·16	..	28 Nov., 33	337
37	13 Dec., 32	23 Mar. ..	·68	·82	1 May ..	·82	·98	9 June ..	·98	1·16	14 Oct. ..	1·16	..	29 Oct., 33	297
39	3 Jan., 33	1 May ..	·66	·81	9 June ..	·81	·98	4 July ..	·98	1·12	4 Nov. ..	1·12	..	19 Nov., 33	298
41	3 Dec., 32	19 Apr. ..	·67	·84	10 May ..	·84	1·00	21 June ..	1·00	1·21	10 Nov. ..	1·21	..	24 Nov., 33	333
62	5 Jan., 33	25 Mar. ..	·67	·82	29 Apr. ..	·82	1·00	30 May ..	1·00	1·21	15 Nov. ..	1·21	..	30 Nov., 33	307

TABLE VIB.

Laboratory No. of Larva.	(A–B) MEASUREMENTS OF INSTARS (IN MM.).														
	1st	A	2nd	B	3rd	C	4th	D	5th	E	6th	F	7th	G	8th
4	·162	·071	·233	·157	·39	·13	·52	·13	·65	·17	·82	·16	·98	·17	1·15
5	·162	·075	·237	·143	·38	·14	·52	·14	·66	·19	·85	·15	1·00	·20	1·20
12	·161	·072	·233	·167	·40	·14	·54	·16	·70	·16	·86	·14	1·00	·16	1·16
26	·167	·068	·235	·155	·39	·14	·53	·16	·69	·15	·84	·14	·98	·14	1·12
30	·165	·068	·233	·147	·38	·14	·52	·15	·67	·15	·82	·16	·98	·17	1·15
33	·163	·071	·234	·126	·36	·16	·52	·16	·68	·17	·85	·15	1·00	·20	1·20
35	·163	·073	·236	·144	·38	·14	·52	·17	·69	·16	·85	·15	1·00	·16	1·16
37	·163	·070	·233	·137	·37	·16	·53	·15	·68	·14	·82	·16	·98	·18	1·16
39	·163	·071	·234	·136	·37	·14	·51	·15	·66	·15	·81	·17	·98	·14	1·12
41	·163	·070	·233	·157	·39	·14	·53	·14	·67	·17	·84	·16	1·00	·21	1·21
62	·162	·073	·235	·145	·38	·15	·53	·14	·67	·15	·82	·18	1·00	·21	1·21
L1. 1	..	..	..	..	..	..	..	..	..	..	·79	·19	·98	·16	1·14
L1. 3	..	..	..	..	..	..	·54	·13	·67	·17	·84	·19	1·03	·21	1·24
L 22. 11 ..	..	..	..	..	..	..	·51	·12	·63	·16	·79	·19	·98	·17	1·15
L2. A1 ..	..	..	·26	·13	·39	·12	·51	·14	·65	·16	·81	·17	·98	·14	1·12
L22. 26 ..	..	..	..	..	..	..	..	..	·65	·17	·82	·21	1·03	·14	1·17
L7. A8 ..	..	..	..	..	..	..	..	..	..	..	·82	·16	·98	·16	1·14
132	..	..	..	..	..	..	..	..	·65	·11	·86	·17	1·03	·18	1·21
146	..	..	..	..	..	..	·51	·19	·70	·16	·86	·12	·98	·18	1·16
158	..	..	..	..	..	..	·47	·20	·67	·15	·82	·16	·98	·17	1·15
169	..	..	..	..	..	..	..	..	·65	·17	·82	·18	1·00	·16	1·16
182	..	..	..	..	·39	·12	·51	·16	·65	·17	·82	·16	·98	·17	1·15
192	..	..	..	..	..	..	..	..	..	..	·81	·17	·98	·16	1·14
198	..	..	..	..	..	..	·51	·17	·68	·16	·84	..	..	..	..
199	..	..	..	..	..	..	..	..	·67	·19	·86	·14	1·00	·19	1·19

Columns headed by ordinates give (A–B) measurements of instars, whilst columns headed by the letters A, B, C, &c., give differences in (A–B) measurements of larvæ in successive instars. All measurements in millimetres.

wholly or partly, into the one preceding it and the whole antenna may be withdrawn into the head capsule. The same difficulty is encountered when attempting to measure some of the mouth parts and their appendages. The maxillary palps may telescope wholly or partly and the dististipites (Plate 1, fig. A., *dis.*) and appendages connected with them may be withdrawn into the stipites; the mentum may house the prementum. It is considered that the use of antennal segment ratios for distinguishing the different instars is attended by too many difficulties. Table VII. gives the ratios, obtained after many measurements, of the lengths of the antennal segments for all larval instars: all measurements having been brought to a common denominator.

Measurements were made of the distance from the tips of the mandible to the condyles, but quite often when the larger instars are nearing the completion of stadia, the tips of the mandibles become worn, as also do the processes of the nasale.

TABLE VII.—ANTENNAL SEGMENT RATIOS. IN THE COLUMN DEALING WITH THE SECOND SEGMENTS THE UPPER FIGURES REPRESENT THE LENGTHS OF THE SEGMENTS WHILE THE LOWER FIGURES RELATE TO THE CONICAL PROCESSES AT THE APICES OF THE SEGMENTS.

Instar.	Segments of Antenna.		
	First.	Second.	Third.
First	6	9 10	14
Second	16	15 12	16
Third	26	20 15	20
Fourth	40	28 18	24
Fifth	54	38 19	27
Sixth	70	46 20	30
Seventh	90	58 21	34
Eighth	110	68 22	40

DESCRIPTION OF PLATE 1.

Lacon variabilis Cand.

A.* Ventral mouth parts. Dis., dististipites; st., stipites; m., mentum; c., cardo × 24.

B. Ventral view of head showing ventral mouth parts *in situ* × 24.

C. Dorsal view of full-grown larva × 3.

D.* Antenna of sixth larval instar × 60.

E.* Transverse section through head region showing mentum fused with the stipites of the maxillæ. M., mentum; st., stipites; ma., mandible; a., antenna × 60.

* Drawn from permanent mounts.

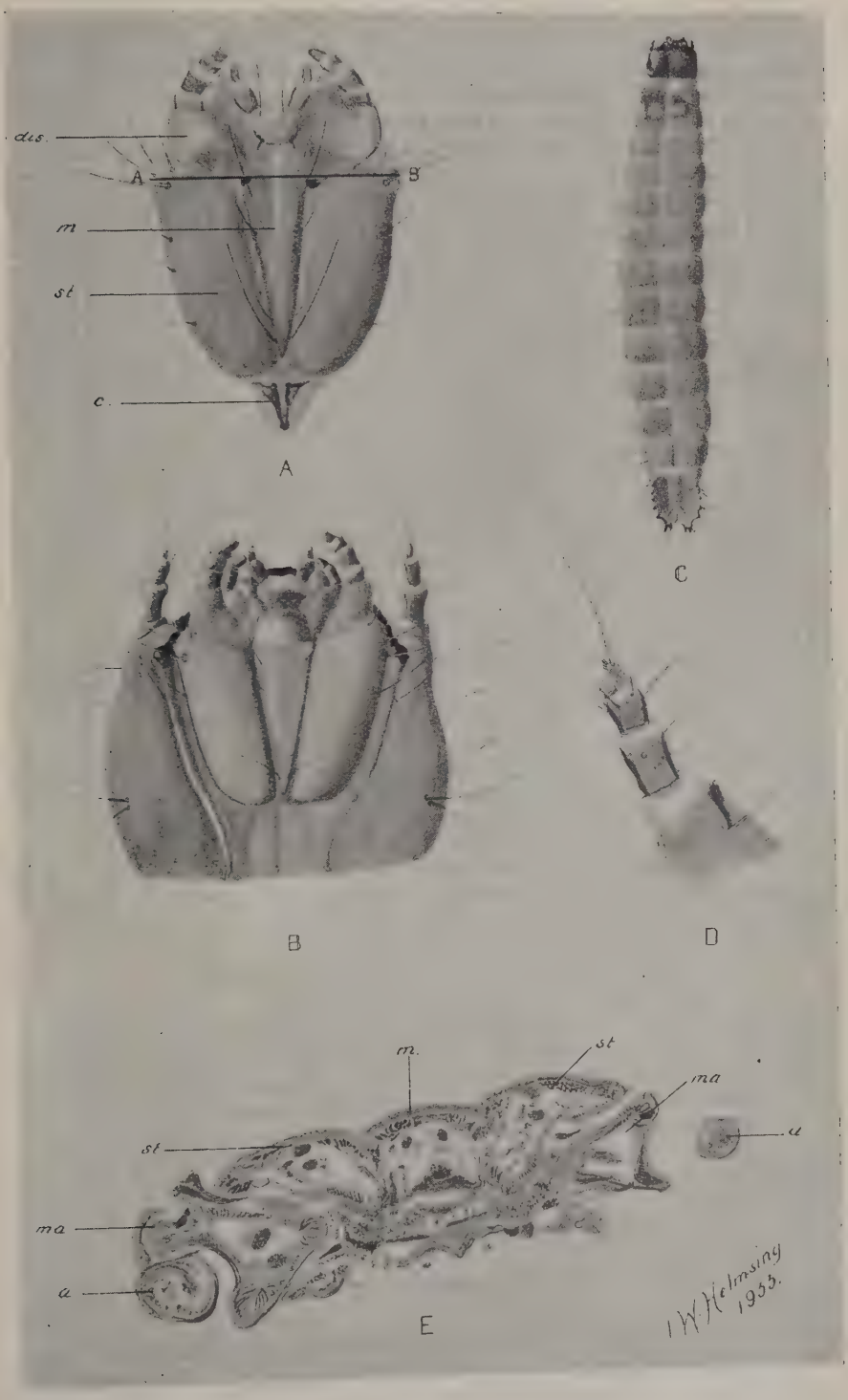

Plate 1.

Width of the Head Capsule.

In all probability this measurement could have been utilised in determining the instars of *L. variabilis* had no other criterion been of outstanding value. Measurements of the widths of the head capsules are not as accurate as those of the ventral mouth parts, as the capsules may be ruptured during ecdyses. Furthermore, the comparatively compact nature of the ventral mouth parts (see Plate 1, figs. B. and E.) does not allow of their losing shape when being measured in exuviæ, whereas the empty moulted head capsules tend to flatten, with consequent increase of width. When dealing with living specimens, the accurate measurement of the ventral mouth parts is much more easily carried out than that of the head capsules. Measurements of the head capsules of each instar are such that, where v = greatest width of the ventral mouth parts, and h = width of head capsule, v = kh, k being a constant which closely approximates to ·60 for any specimen of any larval instar of *L. variabilis*.

Time of Feeding of an Instar.

During 1931, when length measurements only were determined, it was apparent that feeding was not continuous (see Table I.). Later it was observed that, in the continued presence of vegetable material and suitable soil moisture, a *L. variabilis* instar feeds voraciously for a short period immediately after an ecdysis and does not feed again during that stadium. As examples Nos. 4, 5, 30, and 33 of Table VIA. may be cited. Nos. 30 and 33 were in the final larval instar by the middle of May, Nos. 4 and 5 by the end of May: Nos. 30 and 33 pupated in late October and early November respectively, but both had finished feeding by the first week in June while Nos. 4 and 5 had finished feeding by the third week in June. At all times, from May to November, vegetable material and suitable soil moisture conditions were present in the jars containing the larvæ in order to encourage the feeding of this particular instar. If either of the two environmental factors governing feeding is unfavourable immediately after an ecdysis the larva will ingest soil, but if suitable conditions are provided at a later stage during the stadium, the one large feed of vegetable material will be taken. In addition to the effect on the time of feeding, variations in these environmental conditions have an effect on the measurable length of an instar.

Appearance of an Instar Prior to Ecdysis.

Prior to ecdyses all instars become torpid, their general shape and colouring changes, and in many instances the measurable length is increased. The body segments may assume the appearance of a short string of tightly-strung broad-ended beads, with indentations here and there in the lateral and ventral regions. The general colour is paler than that of the normal active larvæ. In this pre-ecdysal state a larva may exist for periods ranging from two days (smaller instars), to as long as two months (last larval instar). This distinctive appearance of the instars before ecdyses, and their heavy feeding immediately after ecdyses, when conditions are at all suitable, were of considerable help during the rearing work of 1932-33 in enabling us to place within a few days the dates of some of the ecdyses of the smaller and moderately-sized instars.

A Peculiarity in Shape of the First Larval Instar.

It was found that the larvæ of *L. variabilis* do not assume the specific shape of the ninth abdominal segment until the second instar

(see Plate 2, figs. C, D, and E), and as a result the first instar can be separated from all other larval instars on the basis of the shape of the ninth abdominal segment alone.

Discussion.

Concerning the use of head width measurements Imms (7) states:—"Dyar has shown from observations on the larval instars of twenty-eight species of Lepidoptera that the head-width follows a regular geometric progression in successive instars. Since the head is not subject to growth during a stadium it is possible, by means of accurate measurements, to determine whether ecdysis has been overlooked during life-history studies." During the past few years some workers (*a*) have attempted to apply Dyar's Law to other orders of insects, not only as a means of determining whether an ecdysis has been overlooked or not during life-history studies, but also in some instances for the purpose of estimating the number of instars in some particular species. The procedure usually adopted is to measure accurately the widths of the head capsules of a sufficiently large random population and then arrange the measurements in an ascending order of magnitude. Measurements are next divided into well-defined groups, if possible, and the mean of each group calculated. The possibility of these means advancing in geometrical progression is then investigated and as much rearing work as possible is carried out.

This procedure has been followed in dealing with *L. variabilis* with this exception, that for greater convenience and accuracy, the greatest widths of the ventral mouth parts (v) were measured instead of the widths of the head capsules (h) ($v = 0{\cdot}60 \times h$, see page 56). In Table VIII. are set out eight groups, together with means, &c., and it is demonstrated by the measurements taken during the rearing of larvæ from eggs to adults, that each group represents an instar. In compiling this table all data as shown in Tables II. and III. are used in conjunction

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(*a*) Metcalfe (12) found that the head measurements of 887 specimens of a random population of *Sitodrepa panicea* L. fell into two sets of groups, the growth ratios of which approximated to two geometric series; it is suggested that these two sets represent sexes. No satisfactory conclusions with regard to the number of early instars could be reached owing to the inadequate number of larvæ obtained.

Miles (13) found that in the Tenthredinidæ studied by him growth and development appear to be more complicated than in the larvæ of Lepidoptera first reported by Dyar. Sex differentiation is considered to render the larval growth of the later instars irregular.

Prebble (14) found that the larval growth rate of three bark-beetles conformed satisfactorily with Dyar's Law. One species has four larval instars and the other two species three.

Andrewartha (1) measured the head widths of 147 larvæ of *Otiorrhynchus cribricollis* Gyll. It was considered that the grouping of these measurements, together with some relevant circumstantial evidence, demonstrated that there are ten instars in the larval life of *O. cribricollis*. For this species Dyar's Law was found to hold good when applied to the average head width of an instar. From this work Andrewartha concludes that "we now have a reliable method for determining the number of instars in the life of soil-inhabiting, leaf-mining, and other inaccessible larvæ." The actual application of the method together with direct evidence shows that, so far as *L. variabilis* and several other species of Elateridæ are concerned, the above conclusion is not altogether correct. The application of Dyar's Law, in its entirety, to the average head width of successive instars seems to have some limitations.

with similar measurements of the larvæ represented in Tables IV., V., and VIA. From Table VIII. it will be seen that the means of the groups representing the last seven larval instars are very approximately in regular arithmetical progression with a common difference of ·15 to ·16 (theoretically ·153).

TABLE VIII.

Groups Representing the Larval Instars.	Observed.				Calculated.*	
	A-B Measurements in mm.			Common Difference.	Mean.	Common Difference.
	Minimum.	Mean.	Maximum.			
1	·161	·163	·167	·067	..	..
2	·21	·23	·28	·15	·23	·153
3	·35	·38	·40	·15	·383	·153
4	·47	·53	·55	·15	·537	·153
5	·63	·68	·70	·16	·690	·153
6	·79	·84	·86	·15	·843	·153
7	·96	·99	1·03	·16	·997	·153
8	1·12	1·15	1·26		1·15	

* ·23 has been taken as the first term and 1·15 as the last.

Table VIB. indicates that the (A-B) measurements of the last seven larval instars of a single larva are also approximately in regular arithmetical progression; for this table the same examples of larval records as given in Table VIA. are used, together with some from Tables IV. and V. The first larval instar is well separated from all other instars, both on the shape of its ninth abdominal segment and on the isolation of its (A-B) measurement when those of all instars are placed in a regular series.

Other Species of Elateridæ.

By the method of grouping the (A-B) measurements of a random larval population, and then using the information as a guide in rearing

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DESCRIPTION OF PLATE 2.

Lacon assus Cand.

A.* First larval instar; dorsal view of ninth abdominal segment × 60.
B. Full-grown larva; dorsal view of ninth abdominal segment × 12.

Lacon variabilis Cand.

C.* First larval instar; dorsal view of ninth abdominal segment × 60.
D.* Second larval instar; dorsal view of ninth abdominal segment × 60.
E. Full-grown larva; dorsal view of ninth abdominal segment × 15.

* Drawn from permanent mounts.

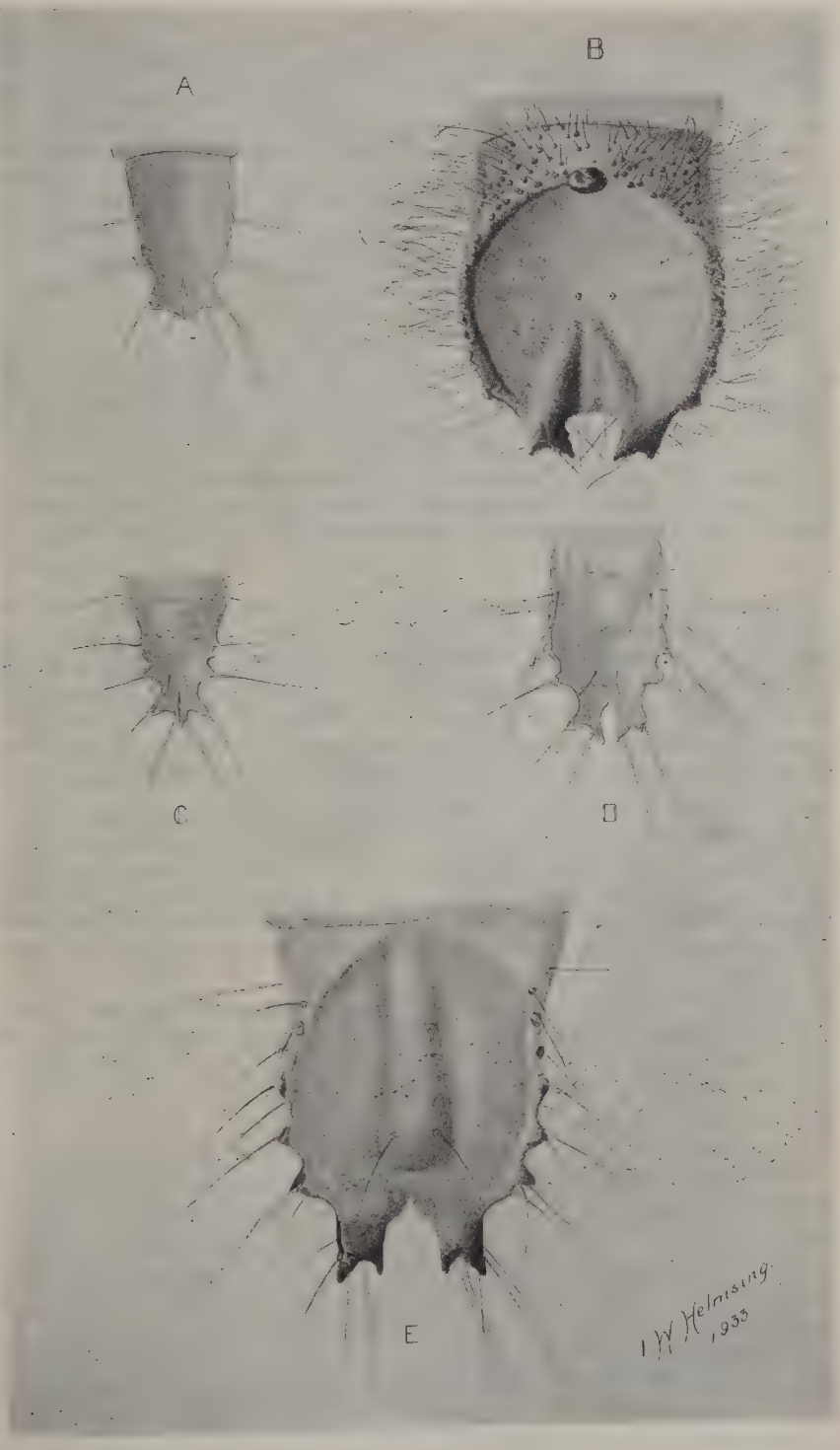

Plate 2.

work, it was found that with *Heteroderes carinatus* Blbn. (a), *Heteroderes cairnsensis* Blbn., five other *Heteroderes* species, *Lacon humilis* Er., *Lacon lateralis* Schw., and seven other *Lacon* species, each group represents an instar. Further, the means of the groups (with the exception of those representing the first larval instars) for each species advance approximately in arithmetical progression. As with *L. variabilis*, so with all the above-mentioned species, the specific shapes of the ninth abdominal segments are not assumed until the second larval instars. The ninth abdominal segments of *L. lateralis, H. carinatus;* and *H. cairnsensis* are illustrated in Plate 3 (figs. A to F), while *L. assus* Cand. is similarly treated in Plate 2 (figs. A and B). This species has been reared from the egg up to the third larval instar and over the last two larval instars, and there is every indication that the larval growth of *L. assus*, as expressed by the increase of the (A-B) measurements of successive instars, is similar to that of the other *Lacon* species with which more complete rearing work has been carried out.

Hyslop (2) in his drawings of the first and last larval instars of *Monocrepidius lividus* illustrates and draws attention to a difference in shape of the ninth abdominal segments which is similar to that found in many of the species mentioned in this article.

Some observations have been made on two species of larvæ (of the yellowish semi-flattened type) the adults of which have not been even generically identified. One here termed B sp.[a] and the other Y sp. (commonly found when chipping in some of the hillside country around Mackay) behave, in so far as growth of the last five larval instars are concerned, in a manner similar to the *Lacon* species, and *Heteroderes* species. The smaller instars of B sp. and Y sp. have not been studied.

No species with the cylindrical type of larva have been studied in detail. The (A-B) measurements of twenty-four cylindrical larvæ of the same species taken from rotted wood could be placed into four distinct groups; the means of these groups approximated very closely to an arithmetic progression. Exuvial measurements taken as the larvæ were reared to adults (four obtained) indicate that each group represents an instar.

Times of feeding of all the *Lacon* species, all the *Heteroderes* species and B sp. are similar to that of *L. variabilis* as described on page 56.

C. LARVAL STADIA.

Lacon variabilis.

As climatic conditions play a great part, both in the variation of the larval stadia of *L. variabilis* and in the incidence of this pest in

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(a) The writer is indebted to the British Museum for the identification of *H. carinatus, H. cairnsensis, L. variabilis, L. assus, L. lateralis*, and *L. humilis*. *H. carinatus* is listed as *Monocrepidius* in Master's Catalogue (1886) (according to a communication from H. Hacker, Queensland Museum), and specimens of *H. cairnsensis* are labelled *Monocrepidius cairnsensis* in the Bureau collection at Meringa. In *Coleoptera of North America* (1883) Leconte and Horn state: "The genus *Heteroderes*, adopted by Candeze, appears to be untenable and heterogeneous; our species are therefore referred to *Monocrepidius*."

a The British Museum authorities identify this species as Gen. (?) (near Athous).

different years (10), fig. 1 has been inserted for the purpose of giving some idea of the climatic conditions prevailing in the Mackay district. Although there are large variations in rainfall in different years, the usual climatic sequence is a wet season of varying intensity between December and March, moderate winter rains, and a comparatively dry spring followed by thunderstorms in early November.

Many field observations made during 1932-33 indicated that, in general, the behaviour of the larvæ of *L. variabilis* in the rearing jars in the laboratory during those years, very closely resembled that of the larvæ under natural field conditions. For the purpose of discussing the stadia of larvæ under natural conditions, the larvæ may be divided into three classes according to the period of the year during which pupation takes place, together with the period of oviposition of the eggs, from which the larvæ emerge. These three classes are—(*a*) Those which emerge from eggs deposited durnig the period November-February and which pupate in the following October to January; (*b*) Those which emerge from eggs deposited in November-January and which pupate in the following March to April; (*c*) Those which emerge from eggs laid by adults from "*b*" class larvæ and which pupate in the following November to January.

Tables IX. and X. present a record of the larval stadia of forty-eight "*a*" class larvæ reared during 1933. It is considered that these tables illustrate the normal growth rate of the larvæ under the usual climatic conditions of the Mackay district (see fig. 1). The true average length

TABLE IX.—STADIA OF LARVAL INSTARS DETERMINED FROM THE RECORDED OBSERVATIONS ON 53 LARVÆ, 48 BEING "a" CLASS AND 5 "b" CLASS.

Laboratory Number of Larva.	STADIA (IN DAYS) OF THE LARVAL INSTARS.								Complete Larval Period.
	1st.	2nd.	3rd.	4th.	5th.	6th.	7th.	8th.	
4	7	14	24	30	32	53	20	164	344
5	8	12	28	9	25	51	50	155	338
12	12	20	34	15	31	34	39	148	333
26	6	7	8	13	22	12	44	37	149
30	9	10	17	14	26	28	43	168	315
33	11	20	22	16	24	20	38	180	331
35	7	7	15	36	25	20	69	158	337
37	13	21	11	17	30	39	39	127	297
39	14	11	17	30	39	39	25	123	298
41	7	37	20	30	34	21	42	142	333
62	12	20	11	13	16	35	31	169	307

TABLE X.—LARVAL STADIA DETERMINED FROM THE RECORDED OBSERVATIONS ON 48 "*a*" CLASS LARVÆ REARED FROM EGGS TO ADULTS DURING 1933.

Larval Instar.	Stadia (in Days).			
	Minimum.	Mean.	Maximum.	Standard Deviation.
1st	5	9·5	14	2·73
2nd	7	14·9	37	6·16
3rd	11	18·9	34	4·82
4th	13	20·2	31	8·48
5th	16	28·2	39	7·16
6th	20	32·8	53	9·78
7th	20	38·2	69	12·11
8th	119	152·0	180	16·67

of the larval period of these forty-eight specimens was 314·8 days. During 1933 a total of 102 "*a*" class larvæ reared from eggs to pupæ spent an average of 302·2 days in the larval state. The forty-eight larvæ of Table X. are included in this number, some of which hatched from eggs deposited fairly late during the November-February period. During 1932, 128 "*a*" class larvæ spent a true average of 279·4 days in the larval state but, as Tables IV. and VIA. indicate, in 1932 a greater proportion of the observed larvæ were hatched from eggs deposited in January or early February than was the case in 1933, when many of the eggs used for rearing purposes were obtained in November and December.

In 1932, six out of 134 larvæ reared from eggs oviposited during November-January pupated during the following March and April, while in 1933, five out of 107 behaved similarly. During the two years, the minimum larval periods of these "*b*" class larvæ were fifty-seven days for those passing through six larval stadia only before pupation, and sixty-eight days for those with eight larval instars. Another "six larval instar" specimen required 161 days to complete its larval life. When the stadia of these "*b*" class larvæ are compared with those of

DESCRIPTION OF PLATE 3.

Lacon lateralis Schwarz.

A. Full-rown larva; dorsal view of ninth abdominal segment × 15.
B.* First larval instar; dorsal view of ninth abdominal segment × 60.

Heteroderes carinatus Blbn.

C. Full-grown larva; dorsal view of ninth abdominal segment × 15.
D.* First larval instar; dorso-lateral view of ninth abdominal segment × 60.

Heteroderes cairnsensis Blbn.

E. Full-grown larva; dorsal view of ninth abdominal segment × 15.
F.* First larval instar; dorso-lateral view of ninth abdominal segment × 60.

* Drawn from permanent mounts.

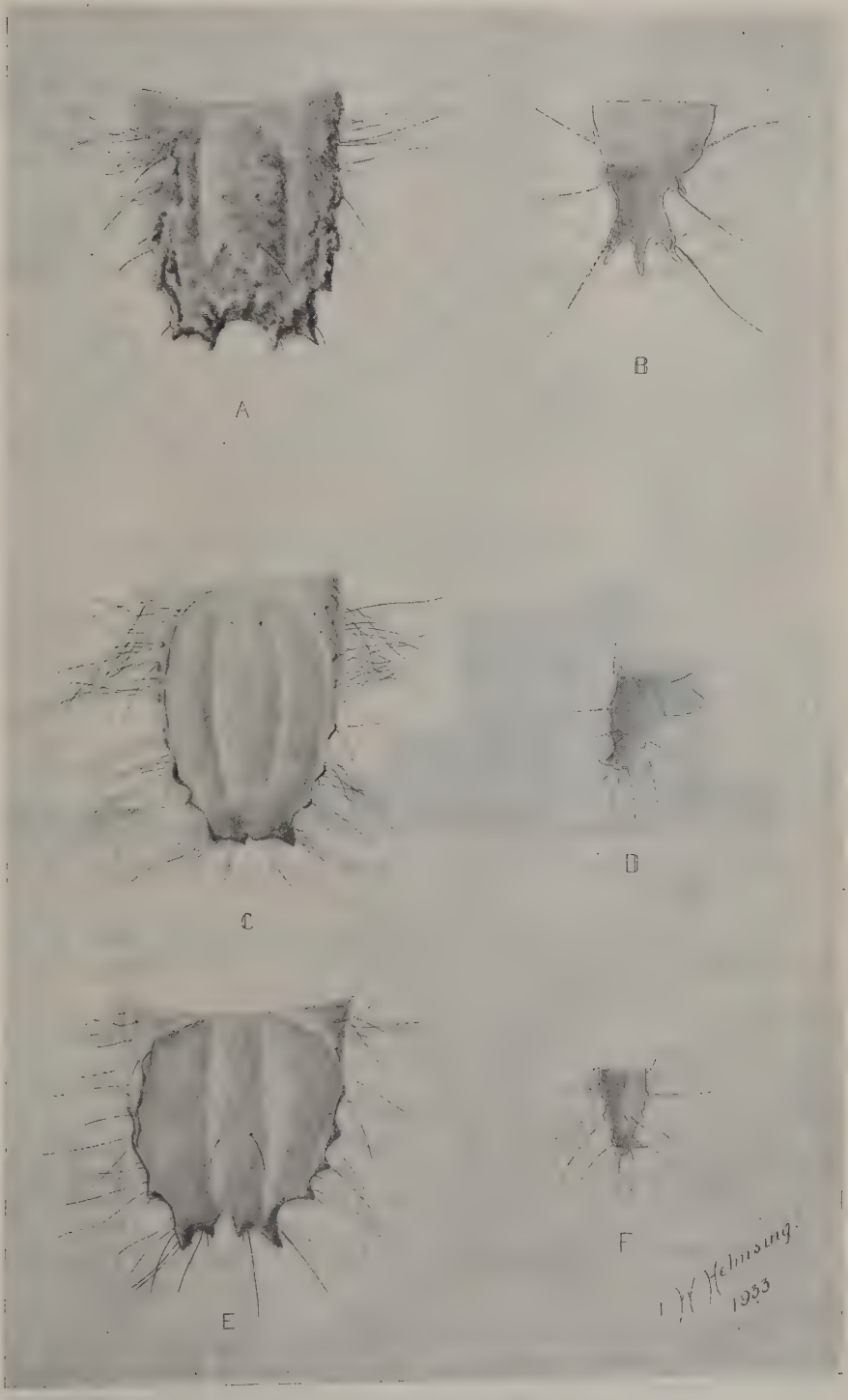

Plate 3.

"*a*" class, as in Tables IX. and X., a shortening of some of the stadia is evident. Of course the last two stadia exhibit the greatest actual reductions, but not always the greatest proportional reductions.

The "*c*" class larvæ are considered to be even more rare in the field than are the "*b*" class larvæ. This is to be expected (see Section D and fig. 1) as the normal climatic conditions militate against the survival of the smaller instars. In the laboratory many of the adults from

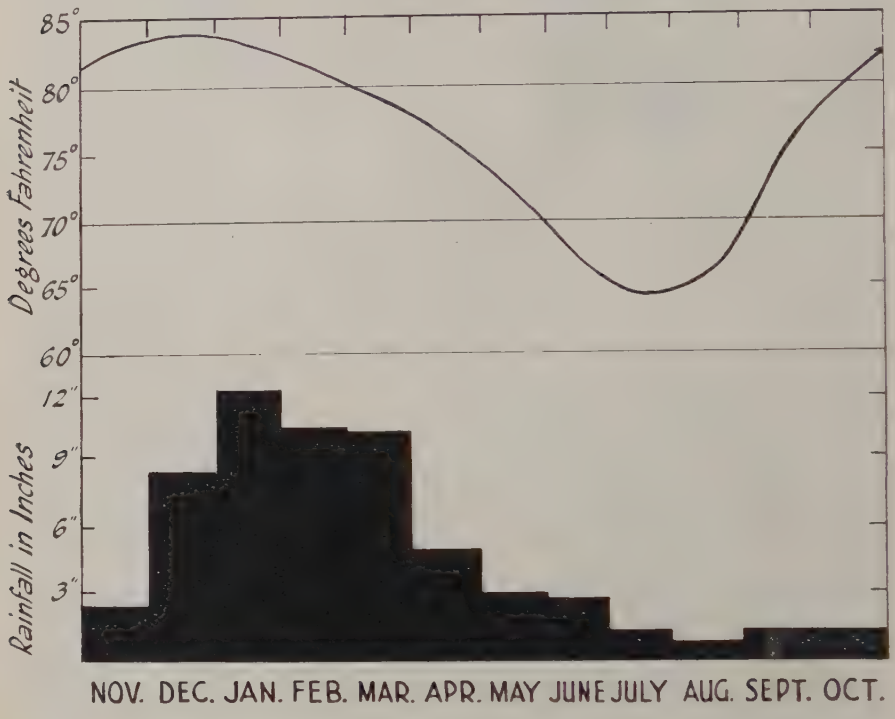

PLATE 4.

Mean monthly rainfall, in inches, and mean 9 a.m. shade temperatures at the Mackay Sugar Experiment Station for the twenty years 1910-1930, both inclusive, but with 1918—an abnormal cyclone year—excluded.

"*b*" class larvæ do not oviposit except under such an artificial condition as increased temperature. It is an easy matter to take the larvæ which emerge from eggs so obtained over the first four or five larval instars, provided the temperature is kept up and suitable soil moisture is provided; under normal environmental conditions the mortality percentage is very high, although once a larva reaches its fourth or fifth larval stadium it will survive under normal conditions. Comparing the stadia of "*c*" class larvæ with those represented in Tables IX. and X. it will be found that generally speaking the earlier stadia are considerably lengthened at the expense of a very noticeable shortening of the later ones.

It is impossible to state definitely whether a small larva found in the field in August or September is in the "*a*" or "*c*" classes as it may be an "*a*" class larva from an egg deposited in late January or February,

which during its early larval life experienced unfavourable environmental conditions. As "*c*" class larvæ are considered to be so rare, it is usual to place any small larvæ found in the field during August and September into the "*a*" class, but this classification may be proven to be incorrect if the larvæ are reared to pupation. As in the "*b*" class so some "*c*" class larvæ pupate at the end of the sixth larval instar, but this has never been found to occur when dealing with any larvæ known to belong to the "*a*" class. If "*a*" class larvæ are kept over the winter in soil with suitable moisture and at the mean shade temperature for October (79·7 deg. F., see fig. 1) they pupate as early as June and never later than August; there are always eight larval stadia.

On the 27th July, 1933, thirty larvæ in their eighth instars were taken from the field. Fifteen were placed in a chamber kept at approximately the mean shade temperature for October, and all had pupated by the 20th August. The second fifteen were reared under normal conditions (i.e., similar to the conditions experienced by the other fifteen except for the increased temperature), and these pupated in late October and November.

Adults of *L. variabilis* have, collectively and sometimes singly, a rather lengthy laying period—collectively from October to February for the majority, and from March to April, for a very few. The vast majority of adults appear in November and early December; the pupal stage is approximately fourteen days and the adults do not remain long in the pupal cells. The first oviposition usually takes place at about three to four weeks after the emergence of the female adult. Irrespective of the exact time of oviposition within the November-February period, and the environmental conditions subsequently encountered by the larvæ, pupation takes place either in the following May-April or October-January. There is no "hang-over," and even all "*c*" class larvæ pupate not later than the January following the May-April during which they had emerged from eggs.

In addition to environmental conditions, some physiological difference in their make-up may be responsible for the fact that some larvæ pupate at the end of their sixth larval stadia and some pupate before the winter, after passing through eight larval stadia.

Other Species of Wireworms.

Under Mackay conditions the following species normally have egg, pupal, and larval periods of very similar length to those of *L. variabilis*, viz.—*Heteroderes carinatus, H. cairnsensis*, five other *Heteroderes* species, *Lacon humilis, L. lateralis*, seven other *Lacon* species and B. sp. These species also pass through larval stadia in a manner similar to *L. variabilis*, i.e., the earlier stadia are short compared to the last one or two, especially the final one. Many specimens of all these species are to be found in the fields or in grass lands in either of their last two larval stadia by July-August, although they do not pupate until September-February. The majority of adults of *L. variabilis* are to be found in suitable places in the field in November and early December. However, this is not so for some of the other species; B sp. is found in the adult stage in largest numbers as early as the middle of October. Adults of *H. cairnsensis* are often found in large numbers with any early appearing *L. variabilis* adults. Adults of *H. carinatus*, the other *Heteroderes* species, *L. humilis, L. lateralis*, and other *Lacon* species are

to be found in greatest numbers during the wet season (January and/or February). *L. lateralis* is usually the species of Elaterid adult most common during the latter end of the wet season; *L. assus* also appears in greatest numbers during the wet season. The earlier larval stadia of this species are also short as compared to the final one. Specimens of two of the unidentified *Lacon* species have pupated leaving exuviæ with (A-B) measurements corresponding to those of larvæ which have not reached their second last larval instars.

D. TECHNIQUE.

Obtaining and Hatching the Eggs.

From most species eggs were obtained by placing female adults in glass jars (see below) which were two-thirds filled with soil of moisture of about one-half that of the "sticky point" (a). Potato tuber was sometimes supplied as *Lacon variabilis* adults and those of some of the other species gnaw it. Eggs were hatched either in the soil in the jars in which the females had been confined, or singly in soil in the receptacles to be used for rearing the larvæ during the smaller instars.

In the matter of distinguishing the female adults from males, size is often of considerable help; for all species with which the writer dealt the smaller specimens were invariably males and the larger ones were females. Adults of *L. variabilis* were examined in more detail than those of other species, and in this species the very small adults are males, the large ones are females, and those of medium size may be either male or female. External sex differences are more definite in the pupal than in any other stage; they are manifest on the venters of the

PLATE 5.

Ventral views of eighth and ninth abdominal segments of *Lacon variabilis* pupæ: ♀ and ♂ × 15.

ninth abdominal segments. The sex difference in *L. variabilis* pupæ as illustrated in fig. 2 is similar to that for all *Heteroderes* species and *Lacon* species examined by the writer.

(a) E. S. West defines the "sticky point" as the moisture content of the soil expressed as per cent. oven-dried soil, when the kneaded soil mass just fails to adhere to external objects. (Observations on Soil Moisture and Water Tables in an irrigated soil at Griffith, New South Wales, 1933.)

When any of the soils used in all of the wireworm work was considered to be in a state of good tilth, it was found that the moisture content was at about one-half the "sticky point."

Rearing the Larvæ.

Four-ounce glass jars with metal screw caps were used as cages in general rearing work with most of the species, but for some of the species with larger larvæ (e.g., *Agrypnus mastersi* Macl.) larger jars of the same type were found to be necessary. Each larva was kept separately in a jar two-thirds filled with soil on which was placed, cut surface downwards, a piece of potato tuber; for larvæ known to be carnivorous, scarabæid larvæ were supplied instead of potato tuber. When dealing with the larger larval instars of all species, the soil moisture in the rearing jars was kept at a little under one-half the "sticky point" for the soil used. The older larval instars of all species can withstand considerable drying out of the soil.

Some writers (8 and 11) have pointed out that it is a relatively easy matter for the older wireworms of the species studied by them to adjust themselves to most unfavourable conditions and still survive, but the smaller instars are very susceptible to changes in environmental conditions. Lane (8) used this fact in formulating a control for *Ludius pruininus* Horn, var. *noxius* Hyslop.

The writer found it impossible to rear the wireworms, with which he was concerned, from eggs to adults without a knowledge of the environmental conditions desired by the younger instars of the different species. Younger instars of the different species might need very different conditions for their survival and normal development. For example, take the case of *L. variabilis* and *H. carinatus*. The larvæ of the former species, if they are to survive and develop normally, must have excessive soil moisture during the lives of the small instars. On the other hand, at the same room temperature, and under similar conditions, the small instars of *H. carinatus* cannot live; a moderately moist soil environment is needed in this instance. Ordinary drain pipes, sunk into the ground to a depth of 2 feet 6 inches and with brass gauze fixed to the lower ends, were at times also used as cages. These were filled with soil up to the level of the ground surrounding the pipes and, as far as practicable, the soil conditions inside the pipes were made similar to those of the surrounding soil. These pipes were placed in well-drained land and as a result it was found that they could not be used for rearing *L. variabilis* from eggs to adults under natural weather conditions, whereas they were, under similar conditions, quite suitable for this purpose so far as *H. carinatus* was concerned.[a] Larvæ of these two species are the wireworms most commonly found in cultivated cane fields in the Central Queensland mill areas.

During 1932, by dint of keeping the soil in the rearing jars at approximately its "sticky point" during the lives of the younger instars, the rearing of *L. variabilis* from eggs to adults was found to be a comparatively easy matter. Also, by providing the necessary conditions for the younger instars of most of the species of the genera *Heteroderes* and *Lacon*, and B sp., fairly satisfactory data concerning their larval lives were obtained. During this year (1932), however, very

[a] A preventive control (9) of *L. variabilis* has been developed, and has proved very satisfactory where topographical and economic conditions are such that the necessary drainage can be done efficiently. This control is based on field observations and the fact that, more so than any other species of wireworm inhabiting cultivated cane fields in the Central Queensland sugar areas, the young instars of *L. variabilis* needs excessive soil moisture for their survival.

few of the smaller exuviæ were recovered from the soil in the rearing jars. Attempts to rear the young wireworms between pieces of damp filter paper, or in small pellets of soil between pieces of damp filter paper, were not successful; under these conditions no larvæ survived. During December, 1932, and during 1933, very small instars were successfully reared by using small salve tins (1 inch in diameter by $\frac{5}{8}$ inch deep) as cages. By the help of the facts reported in Section B. (pp. 44-60) and inspections every second day, it was possible to recover most of the small exuviæ from the soil in these "salve tin" cages (for *L. variabilis* see Table VIA.). When larvæ were in the fourth or fifth stadium they were removed from these small cages to the 4-oz. jars.

Pupæ were seldom affected if removed from their pupal cells. When a pupa was found it was placed in a depression in the surface of the soil (after it had been pressed down) in its rearing jar. The final larval exuvium was very often found attached to the posterior end of a pupa from a larva of the semi-flattened yellowish type. Attachment is usually made by strings (mostly intima of the tracheæ) which have become entangled with the barbed spines at the extremity of the pupal abdomen.

As mentioned in Section B, four adults were obtained from twenty-four larvæ taken from rotted woods. Whilst collecting these larvæ it was observed that some were feeding on the internals of larvæ of the tenebrionid *Uloma westwoodi* Pasc.; when in captivity for six months their environment consisted of broken-up rotted wood, kept damp. As food they were provided with any wood-inhabiting tenebrionid larvæ available.

Measuring the Greatest Width of the Ventral Mouth Parts.

For this purpose use was made of a micrometer eye-piece and objectives of three different powers. Calibration was such that with objective (*a*) 4·25 divisions on the eye-piece scale equalled 0·2 mm., with objective (*b*) 3·0 divisions equalled 0·7 mm., and with (*c*) the measurements were in millimetres direct. When working with *L. variabilis* objective (*b*) was used for all instars, while for specimens of first instars set in slides, objective (*a*) was also used.

Whilst being measured the living larvæ were held on the microscope stage between two glass slides (for the larger instars) or between a glass slide and a cover glass (for the very small instars).

Summary.

1. The reliability of larval length, antennal segment ratios, head width, and the greatest width of the ventral mouth parts ((A-B) measurements), as criteria for determining larval instars of *Lacon variabilis* are discussed. Evidence collected during the rearing of this species from eggs to pupæ demonstrates that any of its larval instars can be recognised by the greatest width of its ventral mouth parts. The application of Dyar's Law to this species is discussed. The (A-B) measurements of a random larval population can be divided into well-defined groups of which each represents an instar. When the means of the groups representing the last seven larval instars are arranged in order of magnitude, it will be seen that they advance in arithmetical progression. The (A-B) measurements of the last seven larval instars of a single larva are also approximately in arithmetical progression.

There are normally eight larval instars in the life of *L. variabilis*, but a small percentage of the larvæ of this species pupates at the end of six larval stadia. The first larval instar is distinguished from all other instars, both by the shape of its ninth abdominal segment and the isolation of its (A-B) measurement when such measurements of all instars are placed in a regular series.

2. By the procedure of grouping the (A-B) measurements of a random larval population, calculating the means of the groups, and using the information as a guide during rearing work, it was found that for seven species of *Heteroderes* and for nine other *Lacon* species, each group represents an instar. Further, the means of the groups (with the exception of those representing the first larval instars) for each species advance approximately in arithmetical progression. As in *L. variabilis* so in all these species the first larval instars are easily distinguished from any other instars.

3. The distinctive appearance of any instar prior to ecdysis and the feeding habits of the larvæ under certain conditions were of practical help in placing to within a few days the dates of some of the ecdyses of the smaller and moderately-sized larvæ.

4. The larval stadia for *L. variabilis* are given; under Mackay conditions larval growth is usually more rapid during the earlier stadia. The larval growth rates of several other species of *Lacon* and several species of *Heteroderes* are similar to that of *L. variabilis*.

5. Technique used by the writer in rearing some wireworms is described. In this connection it should be noted that the critical point in the larval period of all the species with which the writer had to deal is the early instars. In the rearing of the larvæ from first larval instars to final larval instars, success was dependent upon providing the small instars with suitable environmental conditions. The early instars of different species may require, for their survival, quite different environments.

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PLATE 6.

Large white baconers raised under grazing conditions on Mr. C. B. Peter Bell's Maroon Homestead Farm.

Buffalo Fly Control in North-West Queensland.

IN this article it is proposed to outline the methods adopted in North-West Queensland in an endeavour to check the eastward movement of the buffalo fly. But before considering control measures it is proposed to briefly discuss other features which will prove of interest to readers.

For the purpose of this article it is proposed to discuss the subject under the following headings:—

1. The History of Buffalo Fly introduction to Australia.
2. A summary of the life history and the habits of the fly.
3. Methods of control and a description of the machinery in operation in North-West Queensland.

Historical.

The buffalo fly (*Lyperosia exigua*) is a biting blood-sucking fly closely related to, but distinct from, the horn fly (*Lyperosia irritans*) which has caused such devastation in North America and the Hawaiian Islands.

It is thought that it first entered Australia from Melville Island, reaching the mainland with the first introduction of buffaloes in 1825. Three years later, in 1828, buffaloes were shipped to the mainland of Australia, and it is thought that from that time the fly first made its appearance in the Northern Territory in the vicinity of Darwin. With the gradual growth of the pastoral industry the fly has grown into prominence, and in 1912 Dr. Gilruth, the then Administrator of the Northern Territory and a Veterinarian, officially announced that the fly was existent there and might assume serious proportions. Since then many scientific observers have referred to the fly in reports following experience in the Northern Territory.

For some unknown reason the buffalo fly for a considerable time remained localised in the vicinity of Darwin, but of recent years, possibly on account of the fly having more fully adapted itself to changing conditions and environment, it has spread alarmingly, and the northern pastoral country of Western Australia, the Northern Territory, and parts of Queensland are threatened with invasion. Already, North-West Queensland is feeling the effects of the buffalo fly invasion, and not that alone but also the inconvenience which necessarily must follow in its wake, the observance of regulations enacted to control the movements of cattle.

Strange as it may seem Queensland was the last State to be invaded, and this is possibly explained by the fact that little movement of cattle took place into Queensland from the Northern Territory along the coastal stock routes where conditions of temperature and moisture are favourable to the propagation and spread of the buffalo fly. Most, in fact all, movements of stock took place over the Tableland country of the Northern Territory, entrance being made to Queensland at the Lake Nash crossing gate, some distance south of Camooweal.

PLATE 7.
General view of spraying plant at Kajabbi.

PLATE 8.
Side view of plant at Kajabbi, showing the boarded race, top reservoir tank, lower mixing tank, and right centrifugal pump. The engine is housed beneath the tank stand.

In crossing this long stretch of high open country, which experiences particularly cold snaps during the season in which cattle travel, it has been found that the buffalo fly tends to desert travelling stock. This is so since the optimum conditions of temperature and moisture are non-existent. Perhaps another factor has assisted to shield North-West Queensland from invasion earlier, and that is the roughness of the country on the Northern Territory border near the Northern Coast, which prevented natural movement of cattle in an easterly direction.

However, whether it was non-adaptation to Queensland conditions or natural barriers which temporarily arrested the buffalo fly, we are now faced with the fact that the whole of the cattle and dairying country of Northern Queensland is in jeopardy, and only the constant vigil of those in authority, assisted by the pastoralists themselves, can hope to check its fast movement eastward.

The Gulf country of Queensland, and particularly the low-lying coastal belt, is favourable country for the development of buffalo fly, since optimum conditions of temperature and moisture prevail, and the northern coast is thus considered the possible portal through which the rich and wealthy east coast is threatened.

Life History and Habits of the Fly.

In the Netherlands Indies the buffalo fly feeds on the blood of cattle, including zebus, and other races of native cattle, and also buffaloes, but not as far as is known on any other animals.

In Northern Australia, however, the fly attacks buffaloes, cattle of all kinds, horses, mules, donkeys, and in cases of gross infestation it may elect to attack man. Respecting cattle, it has been noted that it prefers bulls to bullocks, or cows, and perhaps dark-coloured beasts are more frequently selected by the fly, but it is certain that fine-haired smooth-coated animals are more frequently the subjects of attack than the long-haired and coarse type. In gross infestation, however, neither of these factors is of importance.

The female lays her eggs in bovine manure, the eggs being deposited in the cracks and crevices of fresh fæces. Here the stages of the life cycle are gone through, the egg developing into the larva, the larva to the pupa or cocoon, and finally the adult or imago stage is reached. Murnane, who made investigations for the Commonwealth Government on the buffalo fly question in North Australia, has stated that the entire life history may be completed in nine days. Hence, under suitable conditions, it is seen that commencing with a small infestation, a gross infestation could soon be experienced.

The adult fly is a slender insect, metallic grey in colour, and about half the size of the common house fly. This is contrary to the opinion that I have heard voiced by many people who suppose the insect to be of large proportions, possibly because of the name. But the name is only indicative of its original host, the buffalo, and has no bearing on its size whatsoever. It can be easily distinguished from the small bush fly so commonly found in the Gulf country. The small bush fly is black in colour, whereas the buffalo fly is much lighter in colour. When feeding on cattle the glistening wings are held projecting upwards at an angle from the body. When disturbed it rises quickly, but just as rapidly returns to assume its characteristic poise of outstretched wings.

PLATE 9.
The spraying race from the entrance.

PLATE 10.
The loading race at Railway Siding.

Under natural conditions it favours certain parts of the body behind the poll and the base of the horns, the withers, the lumbar region, and low down in the sheltered portions of the flanks and ribs. Undoubtedly these protected parts are favoured since they are inaccessible to the continuous switch of the tail.

Upon careful examination the most striking feature of the fly is its proboscis, which forms a rigid tube-like prominence somewhat swollen at the base, and this is forced through the skin of the host like a needle. A pair of finger-like palps lie along the side of the proboscis. Frequent and heavy rains reduce the number of *Lyperosia* in the field by washing out the dung pads and making them unsuitable for the larvæ. Long dry periods desiccate the pads so quickly as to render them unfit for the developing larvæ. Under either of these conditions, the incidence of the fly decreases.

Seasonal Incidence.

The buffalo fly has a seasonal incidence, its numbers increasing enormously with the advent of the rainy season, which in North-West Queensland usually extends over the months December to March or April. By the end of the wet season and for a short time afterwards the fly is present in gross numbers. The conditions existing in July and August are not so favourable to its propagation, so it is found that in these months when the cold weather appears the fly infestation is at its lowest. With the rising temperatures onwards, until December, it will remain at the point of lowest infestation, but again with the onset of the wet conditions the incidence reaches its maximum.

Effects of Infestation.

When suddenly exposed to gross infestation, cattle have been observed to exhibit intense "fly" worry, evinced by restlessness, constant switching of the tail, and tossing of the head. On the other hand, cattle reared in infested country appear to gather a tolerance to the attack of the flies, although upon heavy infestation the worry is noticeable.

However, the fly exacts its toll in the quantity of blood that is drawn during feeding. When flies are present in countless thousands as they sometimes are, the loss of blood must be quite considerable, and the consequent loss of condition great. What condition is lost by this means it is not possible to estimate. Furthermore, the constant irritation and the endeavours of the animal to allay the irritation by rubbing against trees and other objects often leads to the formation of raw granulating wounds about the jowl and dewlap, and as in the case in many Hereford cattle, at the medial canthus or the inner corner of the eye.

There is one redeeming feature of the buffalo fly infestation and that is its seasonal incidence. It has been stressed that the fly is present in greatest numbers during and for a short time after the rainy season. At that time the grass is green and luxuriant, and with plenty of feed the strain on the growing animal is not so heavy. With the dry season, May to December, the infestation is at its lowest ebb, and it is fortunately at the time when the beef animal in the north is hard pressed to exist.

Methods of Control.

In the light of the experience gained by scientists the world over, it has been realised that the control of pests of all descriptions offers

PLATE 11.

Bullocks in the spraying race with plant working. Note the sprays above and below the animals on both sides.

PLATE 12.

The Leichhardt River, at Kajabbi, from the railway bridge, North Queensland.

numerous obstacles. This has been found to be the case in instances where a less active subject than a fly has entered into the picture, hence, remembering that the buffalo fly is a winged parasite, proved to be capable of flying a distance of 30 miles, the right thinking man can readily understand the difficulties which present themselves in devising methods of control.

Not only in Queensland has the difficulty been appreciated. Western Australia too has met similar obstacles, but in Queensland the difficulties are far worse.

In Western Australia it was early realised that a great risk was encountered in bringing cattle from the buffalo fly infested areas of the West and East Kimberleys to the south-west corner of the State, where the State's finest dairy farms are centred. Hence, a scheme was devised whereby cattle before shipment at the port of Derby were subjected to treatment with a substance which experiment proved to be lethal to the life of the fly, i.e., when coming in contact with the fly, it killed. This has proved successful insofar that the fly has not reached Fremantle, where cattle are unloaded since the institution of spraying facilities at Derby. But it must be remembered that the time taken for steamers to reach Freemantle from Derby is some ten days, and furthermore, owing to the presence of pleuro-pneumonia in the Kimberleys, it is compulsory to transport all cattle by sea, and during that sea voyage strong winds and cold conditions are encountered.

In Queensland, the position is a more complicated one. The only practicable exit from the buffalo fly infested areas is overland, and although similar methods of control to those employed in Western Australia have been used, it has been frought by tremendous difficulties. In short, a plant has been erected at a suitable spot, Kajabbi, which place is at the railhead at the terminus of the main stock route from infested area. Here cattle are subjected to treatment with a solution known to be lethal to the fly upon contact. Although the solution used is found to be lethal on contact, unfortunately experiments to date have failed to reveal a substance which on application has any lasting repellant action. Hence the position is that cattle, when once sprayed and placed on trucks, are subject to reinfestation with buffalo fly which choose to desert cattle still remaining in the receiving yards. Thus it is seen that the secret of handling cattle at the railhead is their expeditious trucking and their removal from the scene of operation in a thoroughly wet condition. It is thought that this difficulty has been overcome by the use of long hoses with an adjustable nozzle with which cattle on trucks are sprayed a second time, and their removal is made immediately after the second treatment.

Description of Plant at Kajabbi.

The loading of cattle at Kajabbi involves their passage through a long race leading from the drafting yards to the trucks. For the actual spraying, a specially boarded-in race is used, 108 feet in length, and provided with slide gates at its entrance and exit. The spray itself consists of three lines of 1¼-inch galvanised piping, one line placed overhead and two laterally—each running the whole length of the spraying race. These pipes are fitted with jets placed at 3-foot intervals, the lateral pipes being about 20 inches above the floor level, and the floor is concreted. The jets on the lateral pipes are set at an angle of

PLATE 13.
Rugged bank of the Leichhardt River, North Queensland.

PLATE 14.
Gregory River, near the crossing, Gulf Country, North Queensland.

45 degrees. Those on the overhead pipe are set to force the fluid in a direction straight down.

The fluid is forced through the pipes by means of a centrifugal pump driven by a petrol engine, and the jets capable of throwing a dense mist spray, which satisfactorily saturates each beast, the top sprays effecting the wetting of the backs and heads and the lateral jets the bellies and legs. Approximately 2½ gallons of solution are used for each beast. Cattle are passed into the race to its full capacity, and the pump set in motion, and the animals retained in the race for the minimum length of time to assure complete wetting. Following this the exit door is opened and the animals set in motion, whilst the jets are still in action. When the last beast leaves the race, the pump is cut off, the exit door closed, and the race refilled for the treatment of a second crush full.

Water is conserved in a 1,000-gallon reservoir tank, and is run into a 400-gallon capacity mixing tank, which is directly connected with the spray pipes.

It has been found that the plant at its present working capacity is capable of handling cattle as fast as it is possible to truck them, animals being confined in the spraying race for only three-quarters of a minute. The daily truckings are entirely dependent upon railway facilities, and the fact that trucking must finish in time to enable inspections to take place prior to nightfall.

Results of Spraying.

After spraying it has been the practice to make a series of inspections of cattle trains en route to their destinations. Fat cattle trucked to the east coast meatworks were subjected to as many inspections as possible during transit. In all instances the first examination was made at the spray, the second 30 miles distant, and the remainder at varying distances along the line.

It is pleasing to note that at no time following the double treatment, i.e., in the crush and with hoses on trucks, was buffalo fly found to be present. In many instances dead flies were recovered from beasts after the first treatment in the crush.

Treatment of Manure on Trucks.

When it is remembered that the female buffalo fly lays her eggs in the cracks and crevices of fresh manure, it is apparent that provision had to be made for the efficient disposal of manure. Where possible, destruction was carried out by treating used trucks with superheated steam at a minimum pressure of 160 lb. to the square inch. This method was made possible by the utilisation of a railway engine fitted with steam pipes attached to the steam box.

On occasions this most efficient device could not be availed of. In such instances all trucks were treated with a concentrated borax solution.

Horses and Camels.

Although bovines are the favourite host of the buffalo fly, it was not lost sight of that horses and camels are subject to attack. Consequently, similar treatment was applied to horses and camels leaving buffalo fly infested areas. When in small numbers it was not necessary to pass

PLATE 15.
Lawn Hill Creek, Gulf Country, North Queensland.

PLATE 16.
On the Smithbourne River, Gulf Country, North Queensland.

PLATE 17.
The Byrne River Crossing, Gulf Country, North Queensland.

PLATE 18.
Vehicular ferry crossing the Norman River at Normanton.

PLATE 19.
The wharves at Normanton, Gulf of Carpentaria, North Queensland.

them through the race, and in fact the race was scarcely suitable for highly-strung horses or the long-necked camel. However, it has proved satisfactory to resort to their treatment with hoses only, in which case it has been found quite efficacious.

Conclusion.

In conclusion it must be emphasised that the matter of buffalo fly control is by no means an easy one. It must be remembered that the fly is a winged insect capable of flying considerable distances, and conditions in the Gulf country are suitable for its propagation.

The co-operation of all sections of the community concerned in those areas is essential if a legitimate attempt is to be made to hold the fly in check.

VALUE OF FODDER CONSERVATION.

Few dairy farmers in Queensland can claim that their cows are better butter-fat producers in times of drought than in seasons of plenty. Not many would be prepared to believe that it could be done, but Mr. Ben O'Connor, the veteran Australian Illawarra Shorthorn stud breeder, of Emu Creek, Colinton, has proved it more than once by following a few commonsense rules in farming.

The secret, he says, is fodder conservation. Mr. O'Connor is one of Queensland's most successful breeders of Australian Illawarra Shorthorn cattle, and this success he attributes to the strict observance of three rules: The buying of only the very best stock; liberal feeding; and the conservation of fodder, so that production might be maintained during the driest spell.

"In the first place," said Mr. O'Connor, "a cow that is not worth the best feed that can be grown is not worth keeping. Unfortunately, there are to-day too many dairy farmers in this State who have not yet realised that a low butter-fat producing cow is as expensive to maintain as a heavy yielder. There are just as many who refuse to look ahead and conserve for those inevitable droughts."

When Mr. O'Connor commenced dairying in the Brisbane Valley twenty-seven years ago he decided that the only way to succeed was to start off properly. The first task was to select a herd that would give a profitable return. This he did by travelling far and wide, visiting all the leading studs until he eventually acquired pedigreed stock of the highest quality, going so far as to pay up to ninety guineas for heifers. The result is that to-day Mr. O'Connor has a milking herd equal to any in the State. His fifty cows have returned him as much as £200 in one month.

This breeder severely culls his stock, so that quality will always be maintained. He is a firm believer in feeding his cows in stalls on lucerne chaff and maize meal, in addition to grazing them on lucerne, oats, and prairie grass.

Over 100 acres of Mr. O'Connor's property is cultivated for lucerne and maize, and any surplus growth is stacked for future use. Feeding in times of drought, under those conditions, is not much more expensive than in good seasons, and it is his experience that stock do better and give heavier yields.

Mr. O'Connor is one of the State's most successful dairy stock exhibitors. He claims the distinction of having won more champion group honours than any other breeder in the State. Between the years 1920 and 1929 his Australian Illawarra Shorthorn group was undefeated, and another outstanding performance was the winning some time ago of the champion group, open to all breeders, at the Gympie Show, for a prize of £100. This was carried off by Mr. O'Connor after his cattle had won the event three times out of four. On the fourth occasion the group was runner-up.

The noted Charm of Glenthorn was one of Mr. O'Connor's cows. This beast had over twenty championships to her credit, including the State honour at the Royal National Show, where she also secured the State butter-fat production championship, retaining the title for some time, only to be beaten by the present holder, Elsie IV. of Oakvale, who is her herd mate. This breeder's herd of fifty cows has repeatedly given a yield of 200 gallons of milk daily.—"The Queenslander."

Queensland Weeds.

By C. T. WHITE, Government Botanist.

Gomphrena Weed (*Gomphrena decumbens*).

Description.—An erect, much-branched annual herb mostly about 1 foot to 18 inches high, with a fairly stout tap root, and often rooting at the lowermost nodes. Stems in the upper or younger parts covered with numerous fine white hairs, which disappear almost entirely from the lower or older parts. Leaves somewhat elliptic (obovate-lanceolate) in outline, $\frac{3}{4}$-inch long, tapering at the base into a short leaf-stalk or petiole, smooth above, hairy beneath. Flowers white, borne in oblong or somewhat globose heads, $\frac{1}{2}$–$\frac{3}{4}$ inch long and $\frac{1}{2}$ inch across, lengthening in seed to spikes $1\frac{1}{2}$–2 inches long. Individual flowers $\frac{1}{4}$ inch long, composed of five white, semi-transparent, pointed perianth segments, surrounded at the base by a dense covering of long, white, silky hairs, each flower subtended by a bract and bracteoles, the former much broader and shorter than the latter, but sharply pointed. Seeds dark chestnut brown, smooth and rather shiny, round and flattened, 1 line in diameter.

Distribution.—A native of Mexico and Tropical America, now a naturalised weed in several tropical and subtropical countries. It is reported to have first made its appearance at Townsville about three years ago, having been noticed in a spot where some circus elephants had been feeding. It is now, however, very common along the whole coastal belt, and I have seen it as far inland as Torrens Creek.

Common Name.—I have not heard a common name applied to it.

Botanical Name.—*Gomphrena* from Gomphræna, a name used by Pliny for some plant of the same family (*Amarantaceæ*) from *grapho* I write or paint, in allusion to the highly-coloured foliage. Some plants allied to the present one are much grown in gardens on account of their coloured foliage, e.g., Alternanthera, Amarantus, Iresine, &c.; *decumbens* Latin for decumbent or reclining—in botany decumbent means reclining in the lower part, the upper part ascending or erect.

Properties.—The plant is probably quite a good fodder, though reports from different parts of the State regarding its palatability for stock are very conflicting. Stock on the whole would probably reject it or eat it only in limited quantities when plenty of other feed was available.

Eradication.—So far as I have observed the weed is not a particularly aggressive one, and does not call for any special means of eradication.

Botanical Reference.—*Gomphrena decumbens Jacq. Hort. Schœnb.* t. 482.

Acknowledgments.—I am indebted to the Director of the Royal Botanic Gardens, Kew (England), Sir A. W. Hill, for the specific determination of this plant.

PLATE 20.
GOMPHRENA WEED (*Gomphrena decumbens*).

The Peanut Industry.

A SOUTH BURNETT CO-OPERATIVE ENTERPRISE.

DOMINATING the whole town is the imposing storage and treatment plant of the Queensland Peanut Growers' Co-operative Association —that is the first impression of a visitor to Kingaroy, a thriving centre of the South Burnett, one of the most productive provinces in Australia.

The first season in which peanuts were grown to any extent for commercial purposes in Australia was 1924, and the crop was practically all grown in Queensland, which is now regarded as the State most suitable for peanut cultivation. Very small quantities of peanuts are grown in the Northern Rivers district of New South Wales and also in Western Australia and the Northern Territory, but about 80 per cent. of the total Commonwealth crop is produced in the South Burnett district of Queensland, with Kingaroy as the centre of activities.

A marketing board was created in 1924 at the instigation of the peanut growers of Queensland. This board was formed under the Primary Producers' Organisation and Marketing Acts to have jurisdiction over all peanuts grown in Queensland for sale; and it has done much to foster, extend, and stabilise this industry. The following figures will show how the industry has increased under the control of the Queensland Peanut Board:—

Season.	Growers.	Acres.	Tonnage.	Value of Crop.
				£ s. d.
1924	100	691	231	10,657 10 8
1925	86	450	142	7,024 0 9
1926	250	3,000	827	38,418 4 2
1927	358	6,500	2,246	79,711 0 5
1928	557	11,500	2,886	107,930 13 8
1929	387	5,500	3,618	116,400 9 1
1930	250	2,300	727	25,773 12 6
1931	428	5,000	2,673	103,334 13 9
1932	216	2,000	551	18,788 13 10
1933	307	2,700	1,205	38,255 4 8
1934 Estimates	500	10,000	3,000	..

The production in 1928 and 1929 seasons was more than could be absorbed in the Commonwealth, and, as exporting was not profitable, this led to a restriction of areas in 1930 in an endeavour to bring the industry back to normal conditions.

In 1928 the growers took advantage of the Primary Producers' Co-operative Association Acts in order to form the Queensland Peanut Growers' Co-operative Association Limited, and at the same time growers levied themselves at the rate of ¼d. per lb. of peanuts in order to provide storage and treating machinery. The levy was first deducted by the Queensland Peanut Board from the final payment on the 1927 crop and handed by the Board to the Association.

PLATE 21.

A view of Kingaroy from top of the peanut growers' silo, looking towards Mount Wooroolin, a beautiful park reserve left in its natural state.

Little more than thirty years ago the site of Kingaroy was a cattle station paddock. It is now one of the most solid farming centres in Queensland.

Bulk, storage, equipped with the most modern machinery known for the treating of peanuts for marketing, was erected at Kingaroy at a cost of £55,000, the Queensland State Government guaranteeing

PLATE 22.

Members of the Queensland Peanut Board (left to right).—Messrs. N. J. Christiansen (chairman), C. F. Adermann, A. G. Whiting, L. Cain (Government representative), and N. A. Nielsen.

75 per cent. of the loan. The balance was raised from the 1927 levy, supplemented by the issue of preference shares in the Queensland Peanut Growers' Co-operative Association Limited. The storage capacity of the silos is 2,800 tons; while in a long shed known as the Dump, a further 1,200 tons can be stored, making a total storage capacity of 4,000 tons. The machinery consists of several cleaning

PLATE 23.

Silo, Dump, and Office of the Peanut Growers' Co-operative Association at Kingaroy. The storage capacity of Dump and Silo is 4,000 tons.

PLATE 24.—A PEANUT FIELD, SOUTH BURNETT, QUEENSLAND.

Probably no other district in Australia can surpass the record of the South Burnett in rapid settlement and development, and the relative volume of wealth production.

PLATE 25.—A PROMISING PEANUT CROP NEAR KINGAROY.

In peanut cultivation, as with other field crops, South Burnett farmers have established high standards in agriculture.

PLATE 26.—PEANUTS STOOKED READY FOR THE THRASHER, SOUTH BURNETT.

From Nanango to Goomeri and from the western slopes of the coastal range to the Bunya Mountains are belts of rich vine jungle land, alternating with stretches of fine forest country, containing extensive alluvial flats along numerous tributaries of the Burnett River. The natural agricultural richness of this region is supplemented by immense stands of hoop pine forests in the surrounding ranges.

machines which treat the nuts from the farm at the rate of 10 tons per hour or 6 bags per minute, and grading and shelling machines with an out-turn of 3 tons per hour.

Until 1930 Queensland growers had been growing the Spanish variety of peanuts almost exclusively, but the Queensland Peanut Board undertook to supply also the Virginian Bunch variety for the roasting trade. In order to assist the Board in this endeavour, the Federal

PLATE 27.
A Peanut Thrasher at work on a South Burnett Farm.

PLATE 28.—AT THE END OF THE HARVEST.
Peanuts are trucked direct from the thrasher to the silo.

PLATE 29.

Inside the silo. Top conveyor and feed to bins.

Plate 30.
Graders and desheller, Kingaroy Peanut Silo.

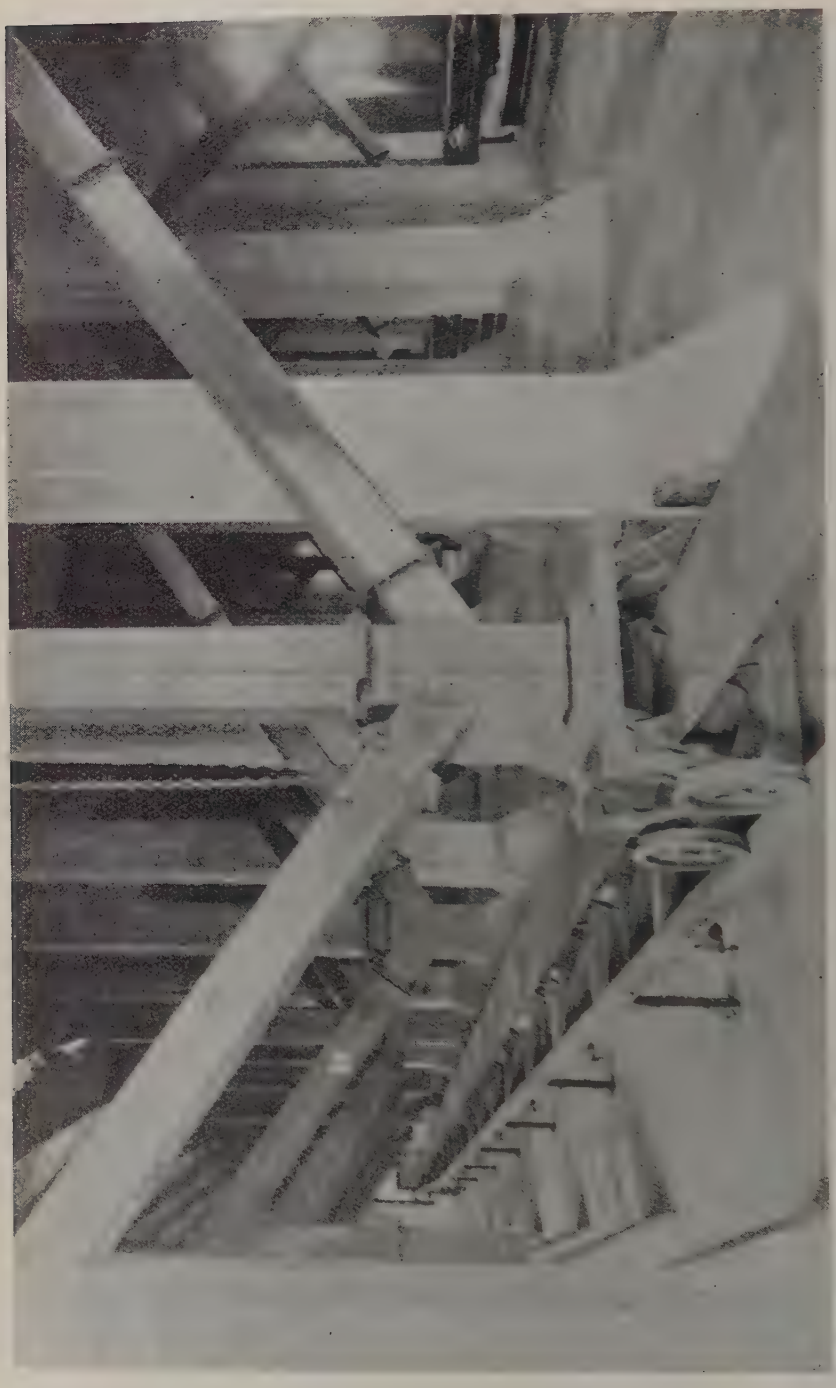

PLATE 31.—CONVEYOR BANDS; KINGAROY PEANUT SILO.

Vast bulk storage, equipped with modern machinery, for the treatment of peanuts for marketing at a cost of £55,000, provide an excellent example of farmers' co-operative enterprise in Queensland.

Government granted an embargo from 1929 to 1930, but, unfortunately, more peanuts were imported into the Commonwealth during the period of that embargo than during any corresponding previous period without an embargo. In 1930, the industry was granted an embargo for an indefinite time.

The 1932 crop was spoiled by dry seasonal conditions in the peanut-growing areas, with the result that there was a shortage of crop and the Board arranged with the Federal Government to permit merchants to import their requirements until the 1933 Queensland crop became available. A certain lack of confidence on the part of growers was responsible for another small crop in the 1933 season, and the Board had again to ask permission to import in order to allow the merchants to retain and supply their customers. This permission was granted

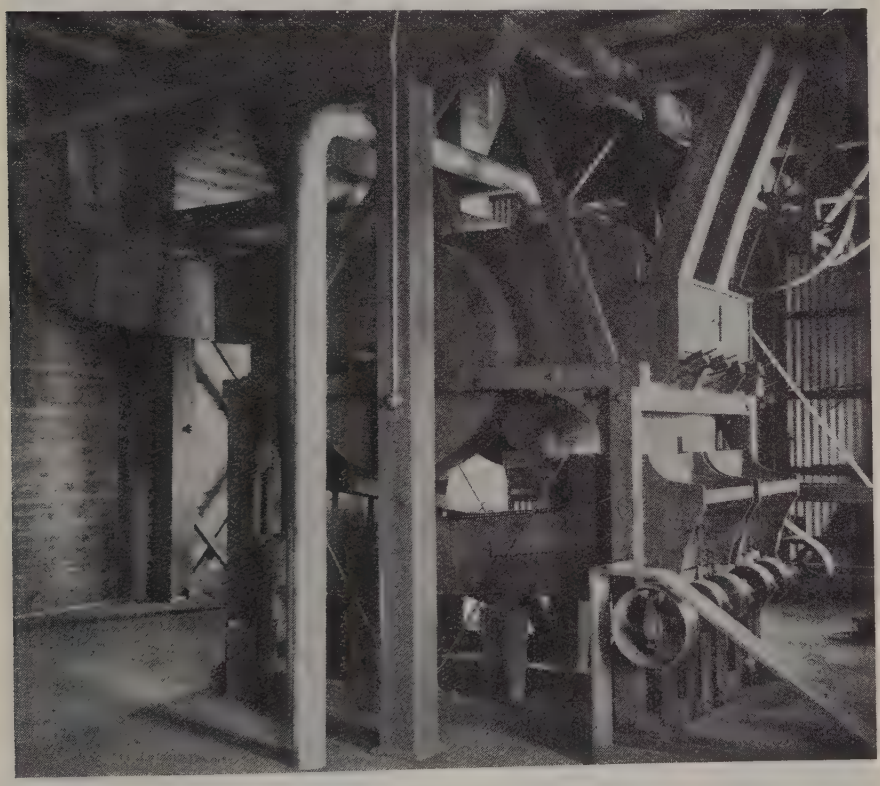

Plate 32.

Final cleaning machine, Kingaroy Peanut Silo.

and the Board, confident of the continuance of the Federal embargo, encouraged growers to plant heavily for 1934 season. The growers, accepting the Board's advice, planted heavily, and were greatly disturbed when the embargo was lifted in December, 1933, after 10,000 acres had been planted. Since then, a very strong case was placed before the Federal Tariff Board for an increase in duty on peanuts in the shell. No decision has yet been given on this question, but peanut growers consider it necessary that an increase should be granted in

order to stabilise the industry. Queensland peanut growers have, to-date, been levied since 1927 to the extent of more than £37,000 and have honourably met all their obligations. In 1933 the Queensland Peanut Board employed 21 males and 156 females apart from the office staff, but this year, with a crop about three times that of last year, only 20 males and 90 females are employed. The lifting of the embargo

PLATE 33.—GIRL GRADERS AT WORK, KINGAROY PEANUT SILO.

In this work great skill is acquired, and the deftness of these cheerful workers is remarkable. The girls are mainly the daughters of district farmers, and represent fine types of Australian womanhood.

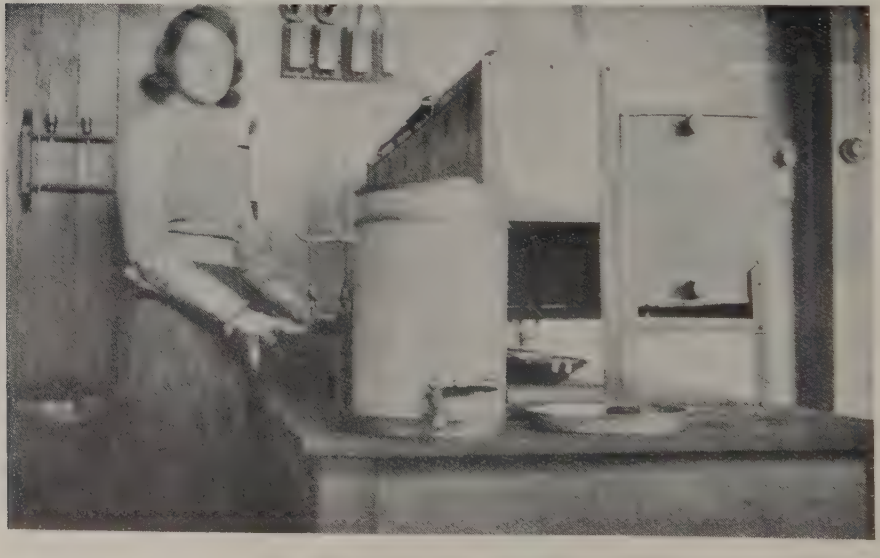

PLATE 34.—THE MOISTURE TESTER AND OPERATOR, KINGAROY PEANUT SILO.

may affect the grading staff principally, as these employees are engaged in the grading of the crop for the roasting trade, that is, the side of the peanut industry which is concerned mostly with overseas competition on the home market.

The wages bill of the Board and the farmers has in the past approximated £30,000 to £40,000 per annum, while manufacturers throughout the Commonwealth employ many hands and pay in accordance with the industrial awards of the different States.

Despite the depression prevailing throughout the world, the peanut industry in Australia has continued to expand and sales kept increasing until 1932, a record year from the selling point of view, and has almost completely disposed of previous surpluses.

In 1933 the Queensland Peanut Board opened a depot at Atherton to deal with the North Queensland crop, while, except in the period 1931-1932, the Central Queensland crop has always been handled in Rockhampton.

Visitors to Kingaroy are assured of a welcome at the silos which are evidence of the importance of the industry and its value as a factor in our rural economy.

SOUTH BURNETT.

Probably no province in the whole Commonwealth has a greater record of rapid settlement than the South Burnett, of which Kingaroy is one of the major centres. This rich district extends, roughly, from the Bunya Mountains and the high lands rimming the Northern Darling Downs on the south to the Kinbombi Range on the north, and from the Coastal Range on the east to the Boyne River on the west.

Thirty years ago it was mainly pastoral land, alternating with vast belts of dense vine jungle (miscalled scrub) or rain forest country. The jungle lands carried immense stands of hoop pine, and, in some parts, fair stands of red cedar. Round about Nanango and Coolabunia were the beginnings of closer farming settlement. The potential agricultural wealth of the district attracted settlers from other parts of Queensland, as well as from the Southern States. Nanango, one of the oldest towns in Queensland, then a pastoral and timber centre, to which gold mining to a small extent was also a wealth contributor, took on a new life. Kingaroy became a thriving terminus. Wondai was still a "one-horse" village. Murgon and Goomeri were merely names on the railway guide. Along the line new townships were gradually taking form.

To-day, Nanango (now a railhead), Kingaroy, Wondai, Murgon (an important railway junction), and Goomeri are populous commercial centres of the rich South Burnett, famed far and wide for the quality, volume, and value of its dairying, agricultural, pastoral, and timber production. Fine public buildings, electric light, and golf links are common to every centre. Several have aerodromes, and one, Murgon, an aviation club. Good roads radiate through their tributary territories; farms and towns are linked by telephone; and on every side are many evidences—including high schools, convent schools, and rural schools—of great cultural and material progress. In every part of the district there is an air of definite, although strenuously acquired, prosperity. It is scarcely believable that such extraordinary development—the clearing and cultivation of such vast areas—is the work of a single generation. The South Burnett was the land of the young man. Its pioneers are still comparatively young men, and in every branch of rural enterprise they have made their mark. Their dairy cattle and other live stock are represented in every important show ring. Their butter has gained the highest awards in State and Empire competitions. Their maize is equal to any grown in Australia; and they have established, and maintain, high standards in other branches of primary production for which district conditions are suitable.

The soils of the South Burnett range from the lighter loams to the deep, rich red and cocoa-coloured volcanic deposits of its jungle regions, and to the heavy black alluvia of its forest country. Added to all these advantages are a healthy climate and a wealth of scenic interest and beauty.

The Cultivation of Maize.

By C. J. McKEON, Instructor in Agriculture.

MAIZE is grown extensively in Queensland along the coastal areas and inland within the 30-inch rainfall region, the chief districts being Moreton, Wide Bay and Burnett, and Darling Downs, which among them usually produce over 80 per cent. of the State's total crop. The next district of importance is the Atherton Tableland, which, due to the comparatively safe rainfall, has much the highest yield per acre over a number of years. It will be seen from this what a vast area of Queensland is suitable for the production of this crop, and also the wide variety of soils on which it is being successfully produced.

Providing the rainfall is sufficient, and the land is naturally well drained, maize can be grown on any good quality soil, the alluvial flats found along rivers and creeks and the deep volcanic soils being particularly suitable for its growth. Good drainage is absolutely essential, for maize will not stand wet feet.

It is one of the easiest crops to grow, and, unfortunately, advantage is frequently taken of this fact, and many crops are grown under conditions which would be fatal to many other crops.

To get the best results maize requires a good soil, in which a plentiful supply of plant food is available, a condition which can only be brought about by an early and thorough preparation of the land before planting, attention to the cultivation of the crop itself, and to the eradication of young weeds during its early growth.

The land should be ploughed to a depth of at least 9 inches during the winter, and allowed to lie in the rough until the early spring. The action of the frost and rain will have a sweetening effect on the soil, and will leave it in a mellow condition. In the early spring the land should receive a second ploughing, which, if possible, should be a cross ploughing. This should not be so deep as the first ploughing, and should be immediately followed by a harrowing and cross harrowing to work the surface soil into a nice fine condition.

If a crop of weeds is turned under during the second ploughing planting should not be carried out for a few weeks at least to allow decomposition to take place. On land which is not too heavy and moist this will be greatly assisted by rolling, as the rolling will consolidate the soil and cause the decomposition to take place much more quickly. It will also at the same time make a good firm seed bed. Rolling should always be followed by a light harrowing.

Preparation of Seed Beds.

The preparation of the seed bed is one of the most important points in the production of maize, and no amount of after cultivation will undo the damage that has been caused by planting in a badly prepared piece of land.

One has only to see the difference, not only in growth but in the colour of the foliage also, between crops grown side by side, and where one has been sown on thoroughly prepared and the other on hastily prepared land, to realise how great the effect is.

Give the young crop a chance to become well established in a good seed bed—and by a good seed bed is meant not only a well-prepared one but one in which the young plants will not have to battle with a host of weeds—and the increased return will more than compensate for the extra time and labour spent.

When to Plant.

The best time to plant naturally varies according to the different districts. In districts which have a long growing season and a comparatively regular rainfall, this can be carried out whenever weather conditions are suitable, from August to late December.

Two very important points are—firstly, to choose a variety which is suitable for the district in which it is to be grown; and secondly, to plan to have the crops tasselling at a time when there is usually a good chance of getting rain. Maize must have moist conditions during tasselling, and if hot dry winds occur during this period the pollen is destroyed and fertilization cannot take place.

Seed should be sown in drills spaced from 3 feet 6 inches to 4 feet apart, nothing less than 4 feet for the tall-growing, late-maturing varieties. As a general rule, single spacing gives the best results, the grains being dropped singly along the rows, with a distance of approximately 12 inches between the grains for the quick-maturing varieties and from 15 to 18 inches for the late-maturing varieties.

From 9 lb. to 10 lb. of seed is sufficient to plant an acre when sown in this manner.

The most satisfactory method of sowing is with a seed drill, as in this way it is possible to get a good even spacing, and no loss of moisture occurs during planting, as is often the case where furrows have to be opened up for hand planting.

Field Practice.

The land may be lightly harrowed even until the plants are a few inches high. This will not only destroy young weed growth, but will also greatly improve germination in the event of heavy rain falling shortly after planting and causing the surface soil to become caked. Many growers are afraid of injuring the young crop, but if harrowing is done on a bright warm day, when the young plants are not brittle, and care is taken to prevent dragging of rubbish which may collect under the harrows, the crop not only will not be injured but will be greatly benefited.

In districts where the rainfall is heavy, and difficulty is experienced in keeping weed growth in check, many growers before planting run out shallow drills a few inches deep with a light plough or other suitable implement, and then sow along the bottom of the drills with the planter. When the young plants are high enough the cultivator is worked through the rows, and is set in such a way that the soil is drawn in around the plants, filling up the depression made when drilling, and thereby smothering the young weeds which have sprung up in the rows. This, of course, to be effective must be done while the weeds are very young.

During the early stages of growth the crop should receive at least two good inter-row cultivations to keep weed growth in check and to keep the surface soil in a nice friable condition, and on no account should the surface soil be allowed to remain in a caked condition while it is possible to work a horse cultivator in the rows.

Harvesting.

The picking of the crop still remains a hand operation, and although machines have been tried, one of which was invented and built in Queensland and which performed well at the trials, none of these has so far reached a stage where it can be successfully worked in the majority of crops.

The ears should be allowed to dry out thoroughly before being shelled, for, apart from the fact that the grain if shelled too early is likely to heat in the bags, a large quantity of grain is broken and damaged during the shelling process and the appearance of the sample is spoiled. A considerable wastage also occurs through the cores being too soft to withstand the pressure of the drums, and these break up into small pieces and pass out through the machine with the grain still attached.

Cost of Production.

To make maize-growing profitable the cost of production has to be reduced to a minimum, and this can only be done by increasing the yields by the use of pure strains of seed which have proved suitable for the locality, and also by practising the best cultural methods. Good quality seed not only gives an increased yield per acre, but also an increased return per bushel, as a better price will always obtain for grain which is of good even type and colour.

The use of modern machinery also is important in lessening the cost of production, and hand work must be eliminated wherever possible; the combined husker and sheller has done a great deal towards this.

Storage.

Maize may be stored for very long periods at no very great cost other than the initial cost of the tanks, yet growers frequently dispose of their entire crops for very low prices during flush seasons; whereas if they had the storage accommodation, and, of course, were in a financial position to store their grain for a time, they would receive very much better prices. One thousand gallon tanks are very suitable for this purpose, and hold approximately 3½ tons of grain. The lids of the manhole and shoot should be so constructed that they can be made quite airtight by puttying or by the use of puddley clay. First and foremost the grain should be dry, and should not contain more than 14 per cent. of moisture at the time it is placed in the tank.

If the grain is showing signs of weevil it can be fumigated by placing a couple of saucers on the top of the grain and pouring into these 1½ to 2 lb. of carbon bi-sulphide. Place the lid on as quickly as possible and puddle up the edges of the manhole cover to make it perfectly airtight. The tank should be kept sealed for twenty-four hours, or longer if desired, and then remove the lids from the manhole and discharge shoot and cover the discharge shoot with strong gauze to prevent the grain from running out. After forty-eight hours the covers can be put back.

Grain for seed purposes should not be left for such a long period, and should immediately after fumigation be exposed to the air, otherwise the germination may be seriously affected.

Carbon bi-sulphide is highly inflammable, and care should be taken to see that no lighted pipe or other naked light is near the tank when the fumes are released.

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When an address on the Order Form is not that to which the Journal has hitherto been sent, attention should be called to the new address, and the former address given. This assists us to identify subscribers, of whom we have many of the same name, often in the same district, as well as in different parts of the State.

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E. J. SHELTON, H.D.A., Senior Instructor in Pig Raising.

PIG raising is now well established over the eastern portion of the State extending from Stanthorpe in the south to the Atherton Tableland in the far north and as far west as Roma, taking in the South Coast, the near North Coast, the Brisbane and Lockyer basins, the whole of the Wide Bay and Burnett, and parts of the Dawson Valley and Central Queensland. Thus, from the far northern highlands, famed for their fertility and generous seasons, right down to the southern border—a stretch of nearly 1,200 miles—pigs are farmed on a commercial scale. Bacon factories—proprietary and co-operative—and meat export works are spaced at convenient intervals throughout the pig-raising country, and continuity of supplies ensures for them a reasonable run of work throughout most seasons of the year, their joint output of bacon and hams for the year 1933 being over twenty million pounds. Thus, in its primary and secondary phases, the pig industry provides a livelihood for populous farming communities, and gives employment to a large number of highly skilled workers.

The principal breeds used are of British origin—the Berkshire, Tamworth, Large White, and Middle White—in the sale of the progeny of which a state of healthy rivalry exists between supporters of the several breeds. This competitive spirit is catered for in the pig sections of agricultural shows throughout the State, and especially at the Brisbane Royal, where the display of stud pigs would stand comparison with that featured at any show here or abroad.

Within the industry ceaselessly working to maintain present efficiency and to effect improvements wherever opportunity offers are a number of organisations—societies representative of all pig industry interests. Especially has the co-operative effort been developed among pig raisers, resulting in the establishment of up-to-date and highly successful co-operative bacon factories both in the metropolitan, Darling Downs, and North Queensland areas. Proprietary factories both on a large and small scale have grown up with the industry, and in more recent years the establishment of the Brisbane Abattoir, and extension of operations there and at other meatworks to provide for the export

trade in frozen pork and for a wider distribution of pork products on the local market, has meant an immense amount to the industry.

Climatic Conditions and Environment.

It is worth stressing here that we are indeed fortunately located from a climatic point of view in comparison with older and colder countries of the world, for our climate certainly favours the open-air system of stock raising; and this system, plus our environment, enables progress to be made with less financial outlay than where winters are long and cold and more intensive housing and feeding is necessary.

Doubtless it is this, plus strict quarantine measures, that has kept the country free of such scourges as foot and mouth disease, trichinosis, pork measles, rinderpest, swine fever (hog cholera), swine erysipelas, and other serious pig diseases.

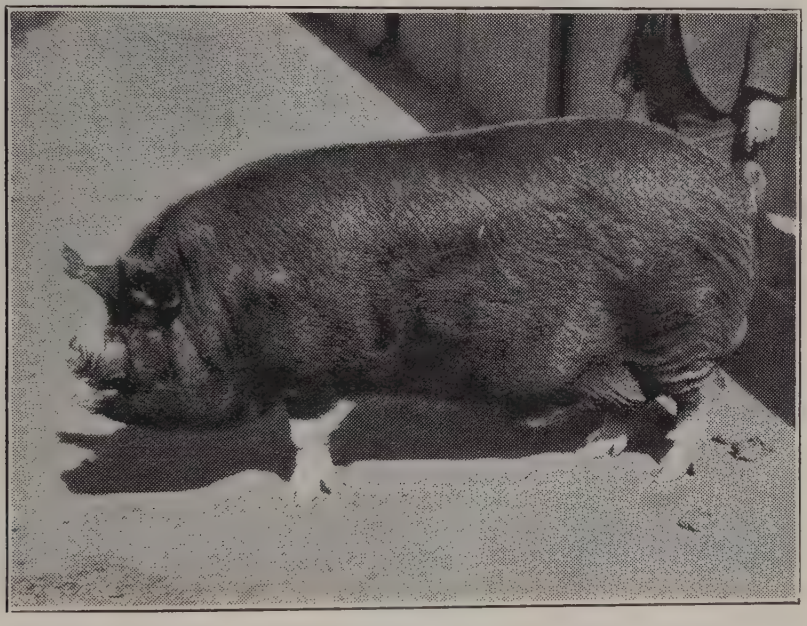


Plate 35.

The Champion Berkshire Boar at the Sydney Show, 1934. Now the property of Mr. J. Barkle, of Kingaroy. This boar has already added to his laurels by winning several championships in keen competition in Queensland.

With such a favourable environment, it is not to be wondered at that the industry has developed so remarkably and that the good reputation of Queensland's pork products, and especially frozen pork, on the overseas markets is being well maintained.

A favourable location, reasonably good seasons, and a constant and expanding market for the products of the business are all essential to the progress of primary industry, and as Queensland is possessed of all these attributes she ranks to-day as the foremost pig-producing State of the Australian Commonwealth.

As with other branches of rural industry, the production of pigs is a specialised business, requiring knowledge and application.

Fortunately, the business is not one requiring a large amount of capital or an expensive outfit or plant, particularly where it is associated with dairying and general farming; the provision of abundant supplies of suitable foods, a liberal water supply, clean, comfortable accommodation, and necessary utensils are among the principal requirements.

To the specialist who intends devoting the whole of his time to pig raising on the intensive system, as in the case of buttermilk piggeries, and suburban pig farms, the business runs along different lines to the combination of cows and pigs associated with dairying.

Apart from the financial side of the proposition, it is essential that there be continuous attention to factors that determine profit and loss in the carrying out of pig farm activities.

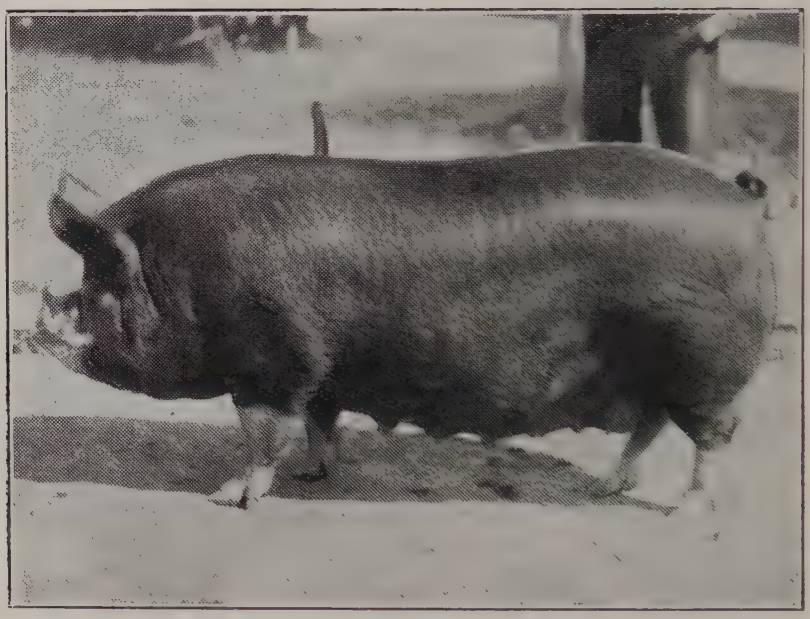


PLATE 36.

The Champion Berkshire Sow at the Royal Easter Show, Sydney, 1934. Parnell Queen 2nd. Shown by the Riverina Welfare Farm for Boys. A daughter of this sow was purchased for Mr. H. B. Kerner, of Queensland, at the Show sales.

Experience has proved that the man, his methods and capital, play the most important part in this venture. A suitable farm, fertility of the soil, rainfall, and climatic conditions are all essential to success.

It has, however, become almost an axiom to say that success depends largely upon production and utilisation of necessary food supplies on the farm, although it is wise to remember that there is always a definite place in stock rations for commercial meals, concentrates, and minerals.

Thus, the food supply and its relationship to seasonal rainfall play an important part. It is essential to remember that the particular requirements of local, interstate, and overseas markets catered for will determine, to an extent, the class of stock kept and the methods of management.

Similarly, marketing facilities, pig prices, and prospective supply and demand are all problems that range before the farmer as he "plans his work" and "works his plan."

Systems of Pig Raising in Queensland.

Long experience has demonstrated that of the various systems of pig raising in operation the most popular, and perhaps that entailing the lowest expenditure, is the system of pig raising in conjunction with dairying in which skim milk and other dairy by-products form the major portion of the food used. This system combines the feeding of dairy products, farm-grown grain, roots, and greenstuff, with some concentrates, and is mostly regarded as the safest and surest road to profit in the keeping of pigs.

More than 90 per cent. of the pork produced in Queensland could be classed as "dairy-fed pork," a food product in universal demand the world over at a premium. Climatic conditions, while variable in regard to rainfall in most of our subtropical districts, are certainly conducive to extension of dairying and mixed farming and to the production of healthy stock under conditions that favour good growth and early maturity. It is worthy of note also that where pigs are kept in conjunction with dairying and mixed farming a comparatively small capital is required to add pigs to the other farm stock. There is little or no risk in so doing, for there is always a ready market for all saleable stock.

Statistics indicate that pigs are particularly healthy in Queensland, and that climatic conditions, being equable, are specially suited to open-air systems.

The system of producing pigs in conjunction with the growing of corn, wheat, barley, oats, and grain sorghums for grain has proved profitable from the mixed farmer's point of view.

This system, combining grain farming with stock raising, is more dependent upon seasonal conditions where circumstances do not permit of conservation of grain and hay and provision of additional root crops.

Pig-feeding experiments now being carried out at the Animal Health Station at Yeerongpilly, in which certain pigs are being fed on a diet from which milk is entirely excluded, have been planned to demonstrate the commercial possibility of feeding pigs with protein meal in lieu of skim milk or any other dairy product in conjunction with home-grown cereals; and that pigs can be produced profitably on farms where the growing of grain, root, and green crops are the main activities, and where dairying is not practised to such an extent as to justify pig raising if dependent on skim milk, buttermilk, or whey as a basic food.

From an export point of view, it is considered there are great possibilities associated with systems of pig raising that combine the use of vegetable and animal proteins as suggested, for, owing to variable climatic conditions over different seasons and at different periods of the year in the dairying districts, there is a marked variation in the number of pigs coming forward monthly for treatment at bacon factories, abattoirs, and meatworks. As will be understood, such fluctuation in supply is prejudicial to the exporter, whose aim must be continuity and sufficiency of supply.

Similarly, it is probable that if there were less dependence upon milk as a food and greater extension of the use of cereals (carbohydrates), plus vegetable and animal foods (proteins), the pig industry would be placed on a safer foundation and expansion of local and export trade would be expedited.

In other words, these feeding experiments aim "to provide data relative to pig nutrition and for purposes of pathological experiments in the feeding and handling of market pigs, and to provide suitable stock for marketing as export porkers or baconers in co-operation with the Queensland Meat Industry Board."

The system of pig raising in conjunction with manufacture of dairy products, in which pigs are fed on factory by-products—buttermilk (or whey)—and on grain, greenstuff, minerals, and water, occupies a very important place in the economic life of the industry, and thousands of pigs are fed and marketed each year from commercial pig farms of this type.

Pigs bred on farms where they are fed on waste food from hotels, cafés, produce markets, and manufacturing establishments contribute a liberal quota each year to pig industry statistics, and have their place in the economy of the industry. Although this system is not at present as extensively carried out in Queensland as in the more populous southern States, there are numerous suburban and metropolitan piggeries around Brisbane and provincial cities. The two lastmentioned systems require larger capital and a wider knowledge of methods of feeding and handling, but under expert control are profitable and are capable of expansion. Suburban pig farming is, however, a business necessitating long hours and considerable labour and expense in collecting food, and unless conducted on specialised lines might readily become unprofitable or a mere "pot boiler"; thus it is often associated with the keeping of poultry as a side line.

Stud pig breeding requires special knowledge and the application of business principles even more so than any other branch of the industry, for unless the stud pig specialist is a business man or woman, and conducts the business on strictly business lines, it is unlikely as such to be successful. The cash capital required depends entirely upon the scope of operations, though stud pig breeding has its limitations, and is ordinarily more profitable when carried out in conjunction with one of the other systems referred to. There is plenty of scope for enthusiastic and capable farmers to further develop this class of stock raising, and the success of those primarily engaged in the business should be an incentive to others. The stud pig breeder needs to co-operate and advertise just as the commercial pig man must organise, and while the former must rank as a member of the Australian Stud Pig Breeders' Society, the latter should not overlook the importance of those organisations at work in the interests of the industry as a whole.

This list of systems of pig raising would not be complete without reference to the many enthusiastic and progressive members of Senior and Junior Pig Clubs, whose operations, while conducted on a limited scale, are, nevertheless, of importance to the industry. As members of the Stud Pig Breeders' Society increase in number, and there is a wider distribution of purebred stock, so also will there be increased interest among the juniors, many of whom will eventually become farmers, following up their project, and becoming the owners of more better-quality pigs and other stock.

Piggery Management.

It is again emphasised that the most progressive pig farmers in Queensland are those who practise and aim at efficiency and whose farms and piggeries are models of cleanliness and well-thought-out method.

Efficient management is an important factor in the success of every undertaking; hence as pig raising is a business venture it must be conducted efficiently to be profitable and worth while.

Nominally, the farmer must have as complete a practical and a theoretical knowledge of the business of pig raising as is possible. It is noticeable, nevertheless, that many farmers who have had little or no schooling in other than the practical side of the business are very often the most successful, for without doubt they have an inborn knowledge of the job.

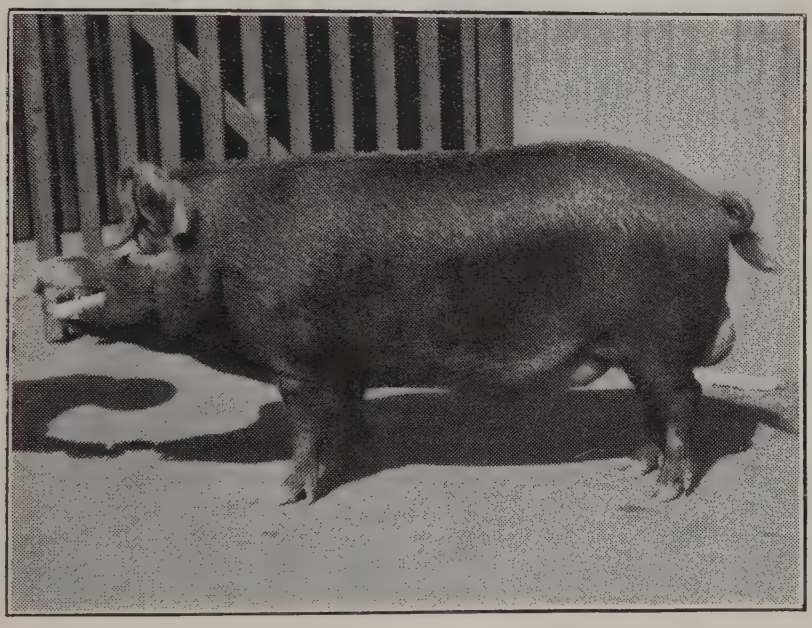


Plate 37.

A. N. White's Champion Tamworth Boar, Sydney Show, 1934. This boar, Blakeney Tom, carries blood of strains that have been successful over a long period of years.

When pig raising is combined with dairying, it will be found as a workable rule that one breeding sow to every ten cows in milk will suffice. In other systems one sow per acre of good cultivation land will be about the correct proportion, with one boar to every fifteen sows kept. If accomomodation, capital, and additional food supplies are available, or if other phases of pig raising are also catered for, it may be possible to increase the number of pigs kept; actually it is better to have food to spare than to lose money by having more pigs than can be comfortably fed and profitably reared.

Experience proves that the Queensland farmer milking sixty cows comfortably handles six sows and one boar together with young pigs, provided some additional food is grown or purchased to supplement the

milk. Breeding stock should not be used for stud purposes until they are approximately ten months of age. After that, if they are carefully handled and kept in reasonable breeding condition, both boars and sows should be productive up to the age of six years or, perhaps, a year or two more. Some authorities prefer and suggest culling all breeders after they pass the age of three or four years.

Whatever happens, correct feeding and management are essential. Pigs necessarily consume large quantities of nutritious food to enable them to develop and mature early, for as baconers to reach 170 lb. live weight in 170 days from birth (birth weight about 2 lb.), and with a ratio of approximately 3 to 4 or possibly 5 lb. of food (dry matter), plus water, to each pound of pork produced, the modern pig is, indeed, as it has been styled, a "pork-producing machine" which must be bred, fed, and properly controlled in order to prove profitable.

PLATE 38.

The Champion Tamworth Sow at the Sydney Show, 1934. The property of J. A. Murray. This sow, Kolodong Success, comes from noted prize-winning strains, and is herself a typical representative of the breed.

Good-quality breeding sows are procurable in Queensland at from £4 4s. at twelve to sixteen weeks of age to about £12 12s. each or so as sows ready for service or in-pig sows. Pedigreed boars are available at from £4 14s. 6d. at three months old to £12 12s. or so as yearlings ready for immediate use.

It has been remarked that in stock raising "half the breeding is in the feeding." It might be stated as equally true that in pig breeding it is impossible to expect good results from feeding inferior quality, slow-growing strains of pigs. A good sow mated to a superior quality boar will produce pigs worth twice as much as those produced by mongrel stock, while cost of production is lower in the former than in the latter. It is not to be expected that pigs will grow rapidly and

produce profitable returns unless improved breeding and selection go hand in hand with correct feeding and management.

Fortunately, fewer farmers keep unprofitable pigs now than formerly. Nevertheless, the pig industry still suffers considerable economic loss each year through the retention on farms of unsatisfactory breeding sows—i.e., sows only producing one litter of less than eight pigs per year instead of two of more than eight each—and also through the use of crossbred, mongrel, lazy, and unproductive boars.

The business of the pig farmer is, and always must be, to help the pigs in their progress from birth to factory, and to feed, handle, and market them in the most attractive and desirable form.

To be profitable, breeding sows should produce two litters per year of no fewer than eight and preferably ten or twelve pigs per litter. There are many sows producing litters of from ten to fourteen, and as it is possible to procure such sows as these it is not an economic proposition to be content with sows that regularly produce six to eight pigs per litter only. We must revise our ideas on these matters and realise that the breeding of productive pigs is a science and an art and not a common unbusinesslike farmyard practice. Unfortunately, too many farmers still depend almost entirely on the purchase of store pigs, and for these, at times, abnormally high prices are paid, and the margin of profit in finishing them for slaughter is considerably reduced.

It is desired to stress more dependence on breeding the pigs on the farm and not so much dependence on purchasing, although if properly conducted there is good profit for both parties in a well-conducted store pig business. The purchase of store pigs at high prices for sale later as baconers at an uncertain value is not usually in the best interests of either party, nor are the risks involved to be recommended.

For the purposes of marketing organisation, co-operative and proprietary bacon factories, meat export works, butchering and trading establishments generally have their place, and much success has attended their efforts. In fact, it is often remarked that if and when the farmer is as efficient at his job as the tradesman, the bacon curer the small-goodsman, and the factory manager, this industry will be regarded as the safest of all agricultural ventures and not the least profitable. There is, of course, much in the way of improvement that can and must be effected at the production end, but attention to marketing requirements by individual pig raisers is actually the first step in effective marketing organisation. In this connection, as in every other phase of the industry, the helping hand of Departmental officers is available on request, and every assistance is gladly and willingly rendered.

If you like this issue of the Journal, kindly bring it under the notice of a neighbour who is not already a subscriber. To the man on the land it is free. All that he is asked to do is to complete the Order Form on another page and send it to the Under Secretary, Department of Agriculture and Stock, together with a shilling postal note, or its value in postage stamps, to cover postage for twelve months.

Poultry in the Orchard.

By P. RUMBALL, Poultry Expert.

THAT poultry raising and fruitgrowing can be combined profitably has already been proved in different parts of the State. With the fowls, the natural conditions in the orchard in the form of range, food, and shade make for good health in the flock; while the birds in turn benefit the fruit trees by keeping down weeds and insect pests, besides contributing a modicum of fertilizer to the soil.

Benefit of Fowls in the Orchard.

In the illustrations used in this article the absence of weed growth in the orchard will be noticed. This is not due to intense cultivation that is generally necessary, but to the presence of poultry. The owners of the farms where these pictures were taken assured the writer that before they kept fowls they were constantly cultivating and that now cultivation is only practised to loosen up the soil for the conservation of moisture. The keeping in check of weed growth means much to the orchardist, while to the fowls it serves as an article of diet which is highly necessary for the maintenance of good health.

Insect Pests.

The fruitgrower knows probably better than I do the large numbers of insect pests which are detrimental to his industry, and that many of them, such as pupæ of the fruit fly, &c., hibernate in the soil. Caterpillars, grasshoppers, crickets, and beetles of many descriptions, which cause damage to fruit and trees, fall easy victims to poultry, while the fowls' habits of dust bathing themselves in the shade of the trees tends to keep the soil loose and prevents the undue growth of surface roots.

Manurial Value.

Another advantage in keeping fowls in conjunction with fruitgrowing is that the manure is distributed throughout the orchard. The grower knows what it costs to manure per acre or what it should cost, but he does not always recognise the value of fowl manure. The quantity voided varies to some extent, of course, with different types of fowls and the method of feeding.

From a report published in the Journal of the Ministry of Agriculture of Great Britain of data collected at the College Poultry Farm, Theale, Reading, the following figures are taken:—

QUANTITIES VOIDED BY DIFFERENT BIRDS.

Kind of Fowl.	Weight.	Manure Voided Weekly.	Percentage of Body Weight.	Manure Voided per Bird per Annum (Fresh).	Number of Birds to Void One Ton per Annum (Fresh).
	Lb. oz.	Lb. oz.		Lb.	
Wyandotte cock ..	6 12	1 13	26·8	94¼	24
Faverolle hen ..	5 12	1 11¼	29·6	88½	25
Growing chicken, 14 weeks	3 12	1 2½	30·8	..	..

The breeds principally used for egg production in Queensland are not shown, but it will be seen that the laying hen and the growing chicken void a greater percentage than an adult male bird, and with high-producing birds, such as the Leghorn and Orpington, a conservative estimate would be 30 per cent. of live weight voided weekly; therefore, a 4-lb. Leghorn would void per annum 62¼ lb. and a 5-lb. Australorp 78, while it would take thirty-seven Leghorns or twenty-nine Australorps to void a ton.

Composition of Fresh Poultry Manure.

The analysis of poultry manure varies with feeding, but that from stock fed on lines usually adopted for the maximum production should comply very closely to the following:—

Moisture.	Dry matter.	Nitrogen,	Phosphoric acid.	Potash.
59·50	40·50	1·47	·71	·49

The commercial value of this manure based on its unit value is from 20s. to 35s. per ton, and the running of 200 fowls or slightly less per acre would be the means of manuring the land to the value of £5 to £7 10s. However, its principal property being nitrogen some will be lost owing to its volatile nature, but there is in addition to the principal concentrates the organic matter—material which is an improvement to all soils.

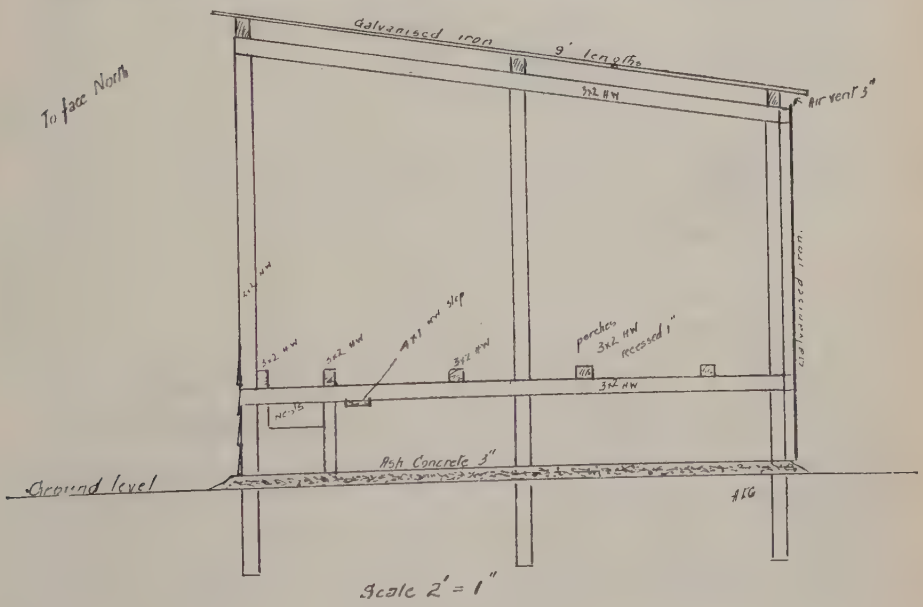


Plate 39 (Fig. 1).

Additional financial returns will depend largely upon the class of stock kept and the attention bestowed on them. Although they will save the grower many days' labour in cultivation, spraying, &c., they will demand daily attention, and to the producer who is not inclined to give them this attention they are not recommended. Only the best should be kept. The breeding, rearing, and feeding should receive the same attention as the poultry farmer devotes to this work, as it is only by these

means that the maximum results will be obtained. Generally speaking, each hen should return a profit over cost of feed, when kept in the vicinity of Brisbane, of about 5s., and 150 to 200 could be run per acre. This, in conjunction with the usefulness of the birds as pest destroyers and the manurial value of their voidings, should prove an incentive to fruitgrowers to work along these lines.

Making a Start.

Although the foregoing may appear attractive, in making a start, caution should be observed. The work of keeping poultry has to be fitted in and the great majority have to gain the experience essential for the rearing of young stock and the feeding of layers. A start should be made by the erection of a poultry house on the lines outlined in the plans, figs. 1, 2, and 3. This house can be used with the addition of a brooder. After the brooding stage it can be used as a rearing house, and ultimately serve its original purpose of housing the adult laying stock. The rearing of chickens in quarters used for adult stock is not usually recommended, but under the conditions of range in the orchard soil contamination does not occur to any great extent.

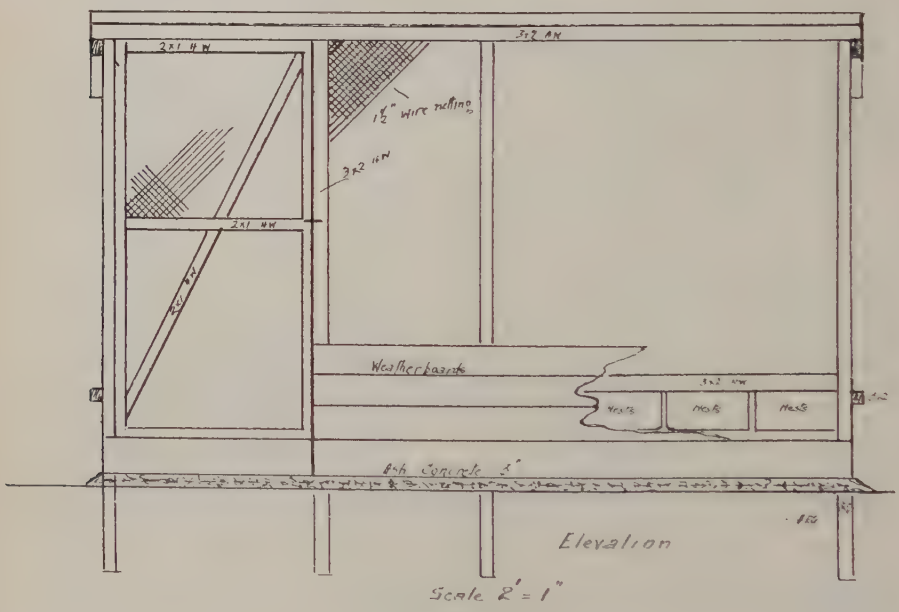
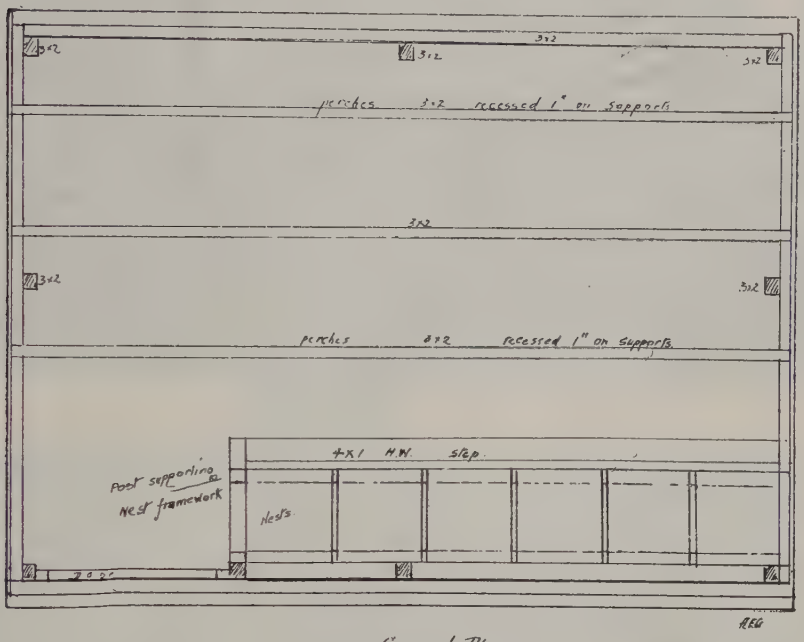


PLATE 40 (Fig. 2).

The purchase of day-old chickens should then be made from some reputable breeder, and so save the necessity of buying breeding stock and the work entailed in incubation. By doing this the number of chickens you have for a start are definite, they will be of the same age, which facilitates rearing and prevents the period of rearing being unduly prolonged and becoming irksome. In making the purchase, be sure and go

to a reputable breeder who maintains the qualities of both numbers and size of eggs in his stock.

Possibly the best months for securing chickens is during August and September. Earlier chickens can be made use of if it is desired to have two lots during the one season, and so allow the first lot to get off your hands before a second lot is commenced with, say, in September.



Ground Plan.

Scale 2' = 1"

PLATE 41 (Fig. 3).

Netting partitions to keep various ages separate may be erected at convenient spaces if desired, but they interfere with the cultivation of the orchard and are not absolutely essential. If chickens are reared in a special house and confined for two or three weeks within a temporary fence they will invariably return to their own quarters to camp. Larger houses than shown in the plan may be built, but units of fifty placed at intervals about the orchard will ensure a better distribution of the birds' droppings and incidentally will cause the birds to forage over the whole of the orchard.

The system of feeding adopted may be either wet mash in the morning and grain at night, or dry mash in hoppers, which is before the birds all day, and grain at night or all mash. The latter system, especially to the novice and to the grower who desires to reduce his work is recommended. The birds by this means are assured of getting all the food they require for egg production, while the grower is relieved of much work daily.

PLATE 42 (Fig. 4).—PAPAWS AND POULTRY.

The luxuriant growth here seen is, to a very large extent, undoubtedly due to the fertilizing value of the poultry manure. The soil is of a light loamy nature, and not naturally rich in plant food.

PLATE 43 (Fig. 5).—POULTRY IN THE SHADE OF A CUSTARD APPLE TREE.

This class of fruit tree offers a maximum amount of shade to poultry in summer.

Reference to the plan, figs. 1, 2, and 3, plainly indicate the simple nature of the house suggested for the purpose of housing fifty laying hens. It is simple in structure, being open fronted, roofed, and walled at back and ends with corrugated iron. A 3-inch open space is provided between the top of the back wall and roof to permit of a good circulation of air. In front weather boards are used as a shield to the nests, the balance being netted in to allow of the stock being protected from predatory animals during the night. The nests are made from petrol tins, one side of which, with the exception of $1\frac{1}{4}$ inch, is removed. This is then turned at right angles to prevent the tin falling through the nest framework. Three perches are shown, 3 by 2 hardwood being used. This is placed on edge and the top corners slightly champered. They are supported on the bottom batten, and by being recessed to the depth of an inch are perfectly firm, and at the same time are easily removed for cleaning purposes.

Plate 44 (Fig. 6).

Citrus fruit growing and poultry keeping is commonly practised in different localities. The benefits to this particular farmer of the combination have been less work and greater returns.

The floor is raised to the extent of 3 inches above ground level to ensure dryness. Concrete is recommended, being readily cleaned and it does not become saturated with droppings. Earthen floors become foul and require renewal at frequent intervals.

The lines suggested on which a start should be made are economical as regards permanent fixtures and equipment, and also relieve the producer for the time being of establishing breeding pens, the necessity of purchasing incubators, and becoming acquainted with the operations of an incubator.

For further information on feeding obtain the Departmental leaflet on this subject.

Marketing Oranges at Home and Abroad.

By JAS. H. GREGORY, Instructor in Fruit Packing.

(*Continued from page 666, Vol. XLI., Part 6—June.*)

PART II.

Packing the Standard Box.

THE Standard Box (18 inches long by 11½ inches wide by 10½ inches deep) is very easy to pack when made correctly. The timber for this box should be milled so that the sides of the box are cut to a minimum thickness of five-sixteenths of an inch. The bottoms and tops should be cut three-sixteenths of an inch thick to allow a bulge to be placed on the finished case without injuring the fruit. This thin timber is prevented from splitting by cleats nailed across the ends of the boards, driving the nails through both the cleat and the bottom and top while making and lidding the case. The Standard Case should have a bulge in the centre of 1 inch to 1½ inches on the top and bottom of the case when packed and lidded.

Table "C."

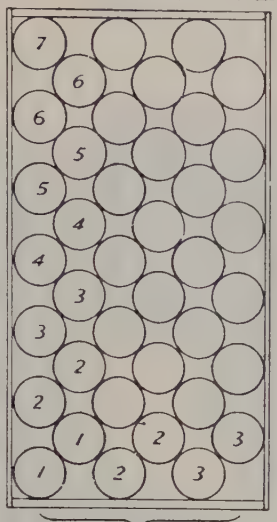
A simplified table of packs to use when packing the Standard Box is as follows:—These packs will give the correct bulge on the top and bottom of the case when the timber for the tops and bottoms is cut to the correct thickness of three-sixteenths of an inch:—

Approximate Size.	Pack.	Layer Count.	Number of Layers.	Total.
2¼ inches	3-3	7-7	6	252
	3-3	7-6	6	234
	3-3	6-6	6	216
	3-3	6-5	6	198
2½ inches	3-3	5-5	6	180
	3-2	7-7	5	175
	3-2	7-6	5	163
2¾ inches	3-2	6-6	5	150
	3-2	6-5	5	138
	3-2	5-5	5	125
3 inches	3-2	5-4	5	113
	3-2	4-4	5	100
3¼ inches	2-2	6-6	4	96
	2-2	6-5	4	88
	2-2	5-5	4	80
3½ inches	2-2	5-4	4	72
	2-2	4-4	4	64
3¾ inches	2-2	4-3	4	56
	2-2	3-3	4	48

It is preferable to use a 3–2 pack instead of a 3–3, as the 3–2 pack will have smaller pockets, and will look better when opened. The same rule applies in using a 2–2 pack instead of a 3–2, when the same fruit can be packed both ways.

How to Read and Use the Packing Table.

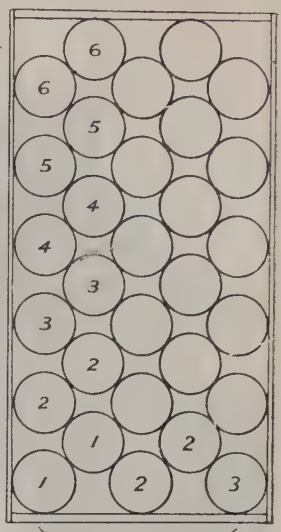
The Layer Count is obtained by counting in the first layer two alternate lines of fruit from end to end in the case, this layer count being 7 x 6.



3-3 Pack.

The Pack gets its name from the way the first six fruit are placed in the layer. The Count is made of the first two lines of fruit across the case.

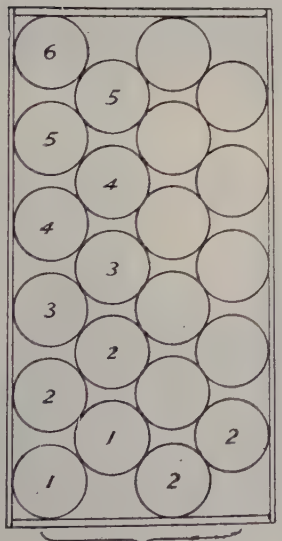
The Layer Count is obtained by counting in the first layer two alternate lines of fruit from end to end in the case, this layer count being 6 x 6.



3-2 Pack.

The Pack gets its name from the way the first five fruit are placed in the layer. The Count is made of the first two lines of fruit across the case.

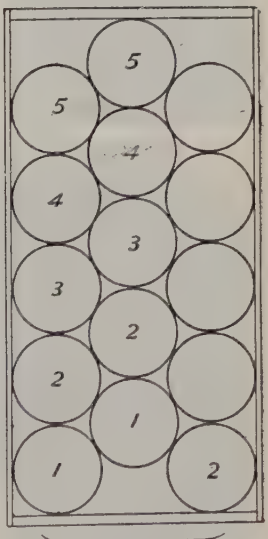
The Layer Count is obtained by counting in the first layer two alternate lines of fruit from end to end in the case, this layer count being 6 x 5.



2-2 Pack.

The Pack gets its name from the way the first four fruit are placed in the layer. The Count is made of the first two lines of fruit across the case.

The Layer Count is obtained by counting in the first layer two alternate lines of fruit from end to end in the case, this layer count being 5 x 5.



2-1 Pack.

The Pack gets its name from the way the first three fruit are placed in the layer. The Count is made of the first two lines of fruit across the case.

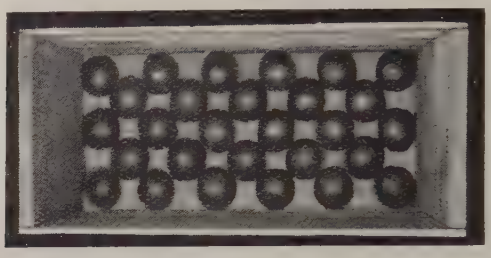
Plate 45.

AUSTRALIAN DUMP CASE.

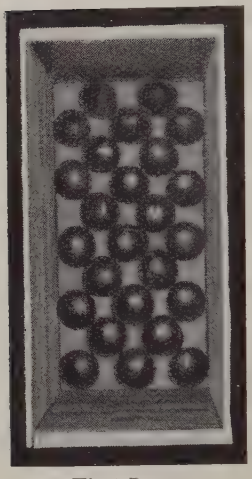
TABLE A.

First Layer.

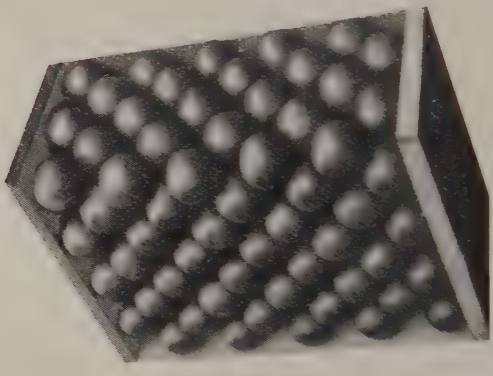
3-2 Pack, 6 x 5 Layer Count, 8 Layers: total, 220 Oranges.



3-2 Pack, 5 x 5 Layer Count, 8 Layers: total, 200 Oranges.

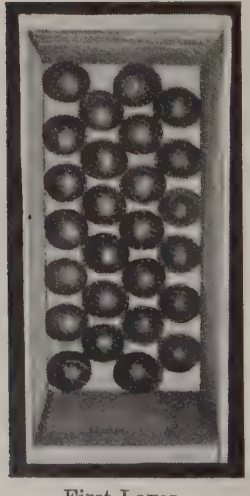


First Layer.

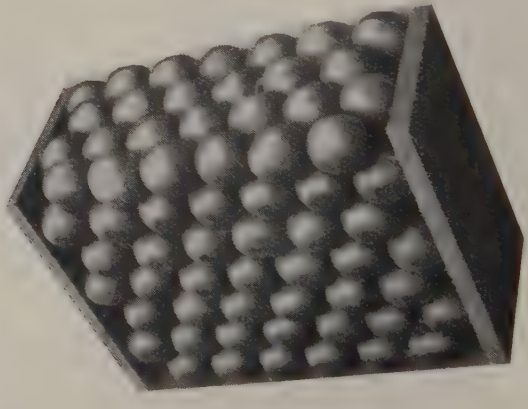


Finished Case. 200 Count.

2-2 Pack, 6 x 5 Layer Count, 7 Layers: total, 182 Oranges.



First Layer.



Finished Case. 182 Count.

2-2 Pack, 7 x 6 Layer Count, 7 Layers: total, 182 Oranges.

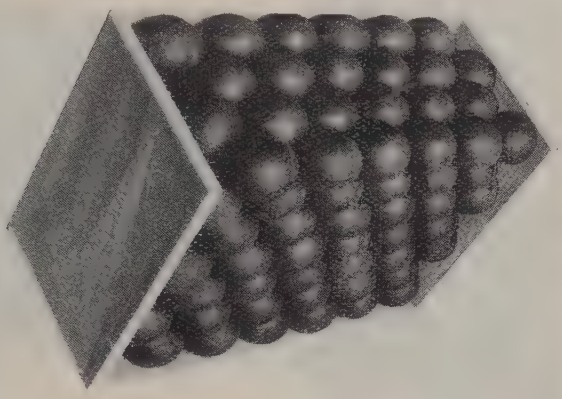
PLATE 46.

AUSTRALIAN DUMP CASE—*continued.*

TABLE A.—*continued.*

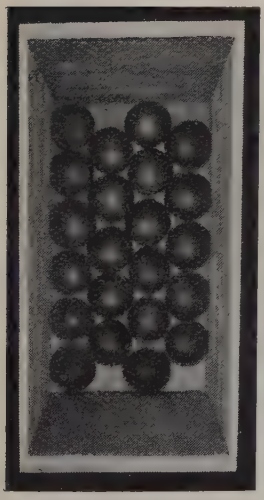
2-2 Pack, 6 x 6 Layer Count, 7 Layers: total, 168 Oranges.

First Layer.

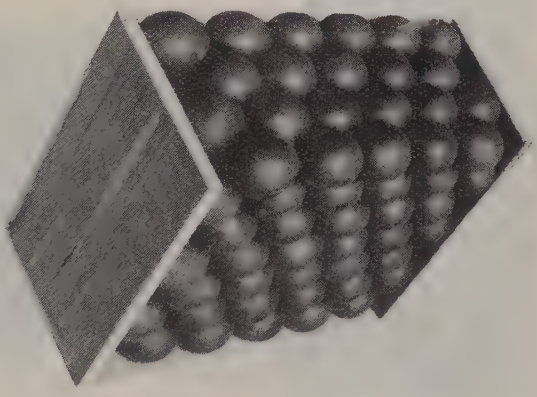


Finished Case. 168 Count.

2-2 Pack, 6 x 5 Layer Count, 7 Layers: total, 154 Oranges.



First Layer.



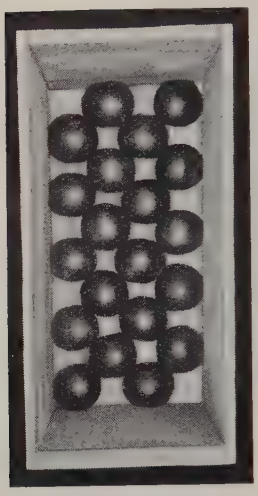
Finished Case. 154 Count.

PLATE 47.

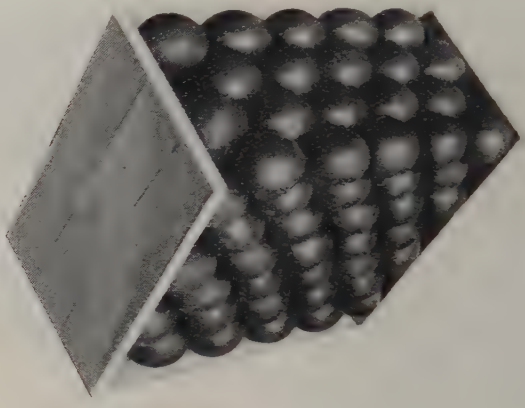
AUSTRALIAN DUMP CASE—*continued.*

TABLE A.—*continued.*

2-2 Pack, 5 x 5 Layer Count, 7 Layers: total, 140 Oranges.



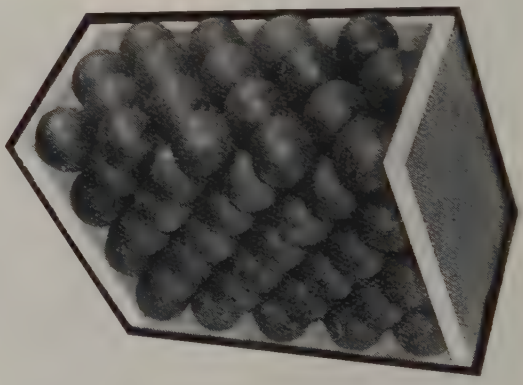
First Layer.



Finished Case. 140 Count.

2-2 Pack, 5 x 4 Layer Count, 7 Layers; total, 126 Oranges.

First Layer.



Finished Case. 126 Count.

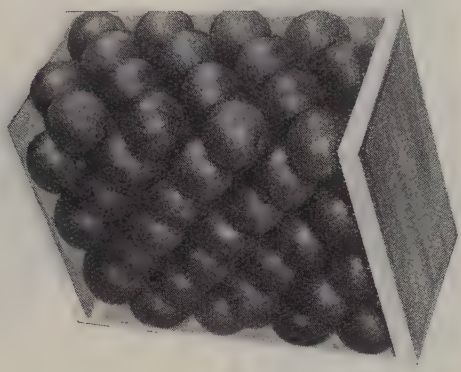
PLATE 48.

AUSTRALIAN DUMP CASE—*continued.*

TABLE A.—*continued.*

2-2 Pack, 4 x 4 Layer Count, 7 Layers: total, 112 Oranges.

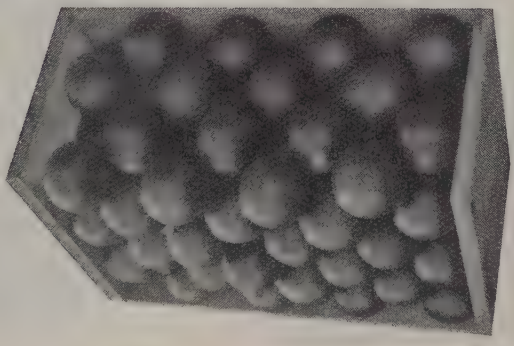
First Layer.
See note on 96 Count.



Finished Case. 112 Count.

2-2 Pack, 4 x 4 Layer Count, 6 Layers: total, 96 Oranges.

First Layer.



Finished Case. 96 Count.

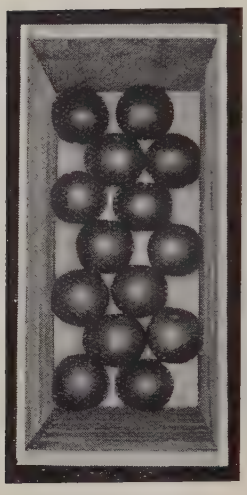
NOTE.—The same number of fruit is contained in each layer of both 96 and 112 Counts, the difference in the packed case being the number of layers—96 containing 6, 112 containing 7.

PLATE 49.

AUSTRALIAN DUMP CASE—*continued.*

TABLE A.—*continued.*

2-2 Pack, 4 x 3 Layer Count, 6 Layers: total, 84 Oranges.

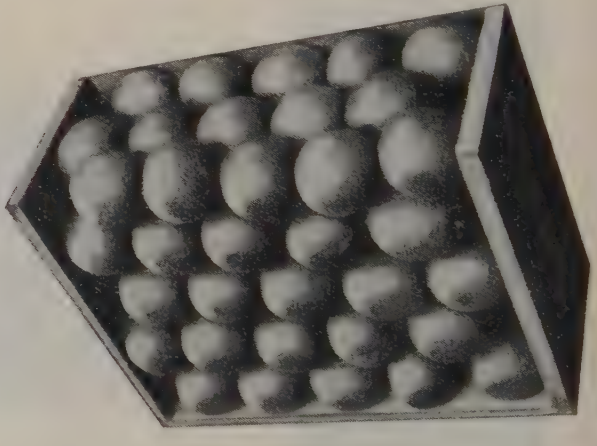


First Layer.

Finished Case. 84 Count.

2-1 Pack, 5 x 5 Layer Count, 5 Layers: total, 75 Oranges.

First Layer.



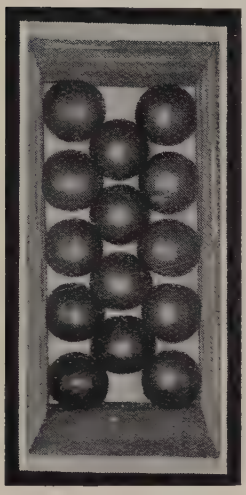
Finished Case. 75 Count.

PLATE 50.

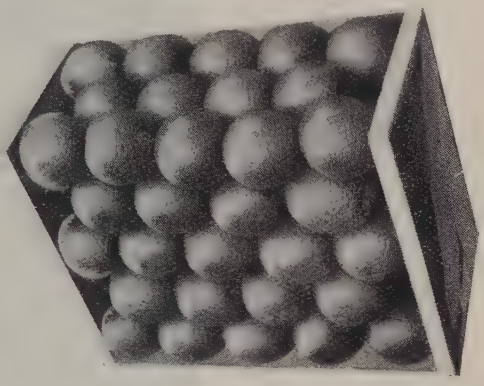
AUSTRALIAN DUMP CASE—*continued.*

TABLE A.—*continued.*

2-1 Pack, 5 x 4 Layer Count, 5 Layers: total, 68 Oranges.

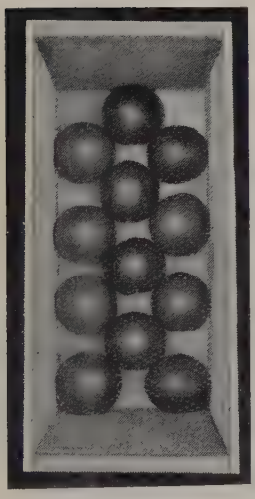


First Layer.

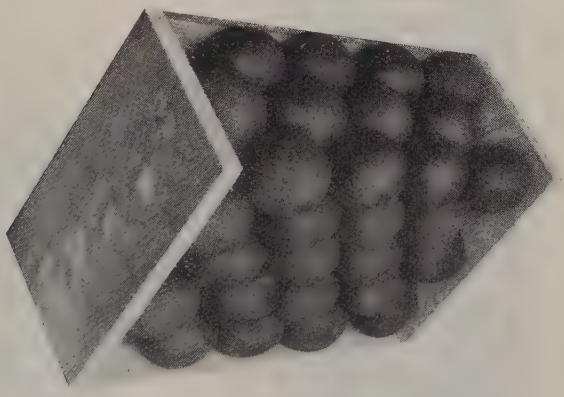


Finished Case. 68 Count.

2-1 Pack, 4 x 4 Layer Count, 5 Layers: total, 60 Oranges.



First Layer.



Finished Case. 60 Count.

PLATE 51.

AUSTRALIAN DUMP CASE—*continued.*

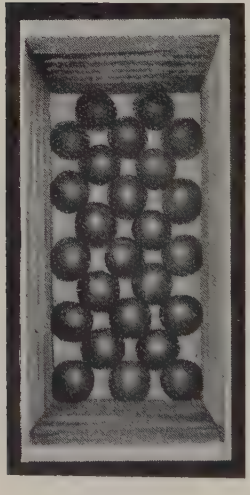
TABLE B.

3-2 Pack, 5 x 4 Layer Count, 8 Layers: total, 180 Oranges.

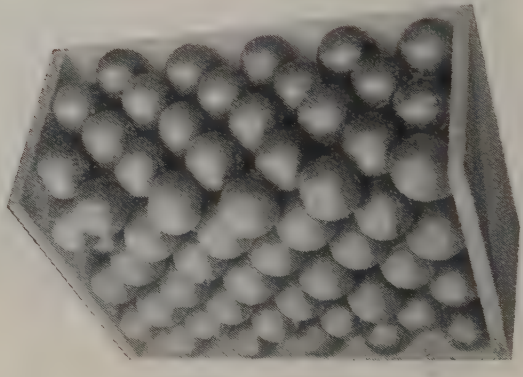
First Layer.

NOTE.—The same Layer Count (3-2, 5 x 4) is used when packing 158 Pack, which contains one layer less.

3-2 Pack, 5 x 5 Layer Count, 7 Layers: total, 175 Oranges.



First Layer.



Finished Case. 175 Count.

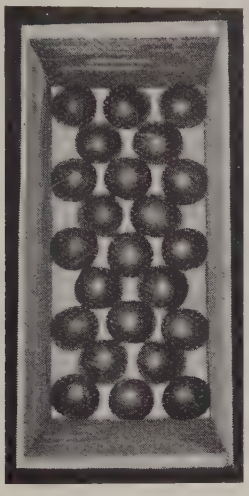
NOTE.—The same Layer Count (3-2, 5 x 5) is used when packing 200-pack, which contains 8 layers.

PLATE 52.

AUSTRALIAN DUMP CASE—*continued.*

TABLE B—*continued.*

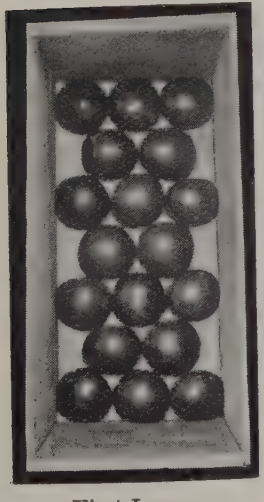
3-2 Pack, 5 x 4 Layer Count, 7 Layers, total, 158 Oranges.



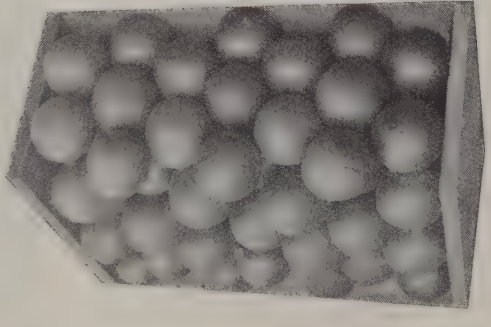
First Layer.

NOTE.—The same Layer Count (3-2, 5 x 4) is used when packing the 180 Pack, which contains one layer more.

3-2 Pack, 4 x 3 Layer Count, 6 Layers: total, 105 Oranges.



First Layer.



Finished Case.

PLATE 53.

Table "D."

Intermediate Packs for the Standard Case.—Avoid using these packs as much as possible. Use them only for types of fruit that do not come to the correct height when the packs mentioned in Table "C" are used:—

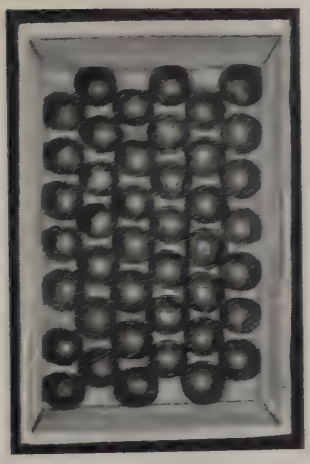
Approximate Size.	Pack.	Layer Count.	Number of Layers.	Total.
2¾ inches	3-3	8-7	5	225
	3-3	7-7	5	210
	3-2	8-8	5	200
	3-3	7-6	5	195
2½ inches	3-2	8-7	5	188
	3-3	6-6	5	180
	3-3	6-5	5	165
	3-3	5-4	6	162
	3-3	5-5	5	150
2¾ inches	3-3	5-4	5	135
	3-3	4-4	5	120
	3-2	6-6	4	120
3 inches	3-2	6-5	4	110
	3-2	5-4	4	90
	3-2	4-3	5	88

Bringing the Pack to the Correct Height in the Case.—Oranges packed in the Standard Case should be packed 1½ to 2 inches above the top of the case, and be gently eased into position before applying the lid. This operation is done either by using a case press, or by placing blocks under the ends of the case and using a dumping lid, which is placed on the case and held in position whilst the ends of the case are gently bumped, the fruit settling gently into the pockets of each layer. When using the press or blocks for the process of dumping, care must be taken to see that the bottom of the case is kept clear of the floor or nailing-down stand, so that the bottom of the case can bulge when the nailing-down is complete. A good dumping lid is made by thinly padding a piece of wood the same size as the lid of the case with hessian or a similar substance. After nailing the Standard Case should have a bulge on the top and the bottom of from 1 inch to 1½ inches. Remember tight or closed packs, such as count 175, should not be brought as high in the case as the open or loose packs, such as count 180.

Where lids and bottoms are cut too thick for them to bend easily when being placed on the case, it is better for the packer to reduce the height of the fruit in the case to avoid squeezing or pressure marks. The advantages of using the correct bulge can easily be offset by badly-milled case lids and bottoms causing damage.

STANDARD CASE.

First Layer.
3-3 Pack.

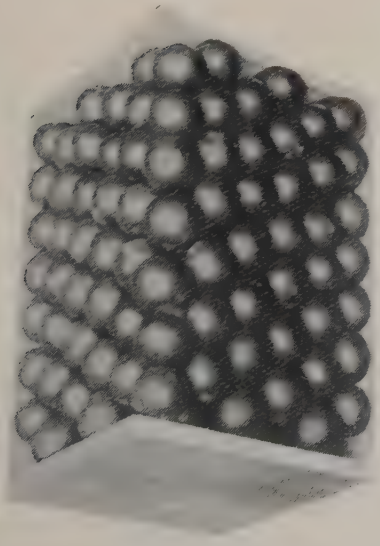


7 x 7 Layer Count, 6 Layers: total, 252.

First Layer.
3-3 Pack.

7 x 6 Layer Count, 6 Layers: total, 234.

Finished Case.



3-3 Pack, 252 Count.

Finished Case.

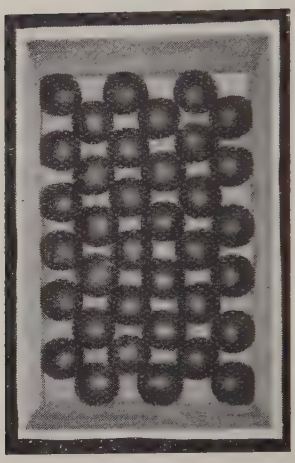
3-3 Pack, 234 Count.

Note the alignment of the fruit in the case.

PLATE 54.

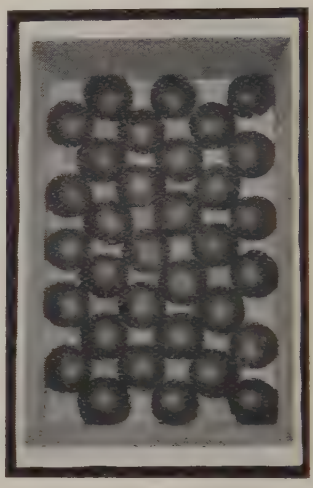
STANDARD CASE.

First Layer.
3-3 Pack.



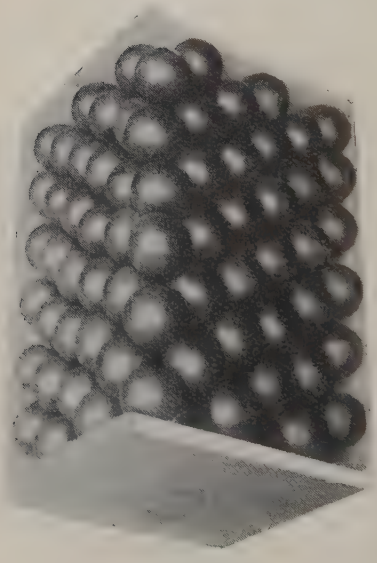
6 x 6 Layer Count, 6 Layers:
216 Count.

First Layer.
3-3 Pack.



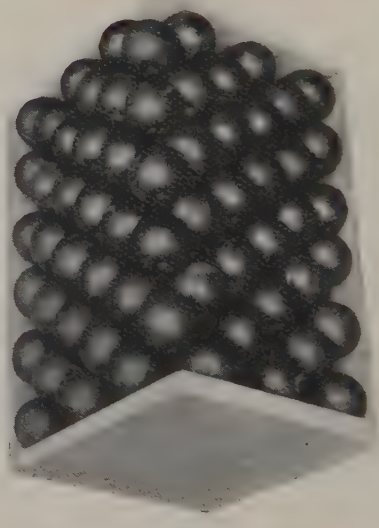
6 x 5 Layer Count, 6 Layers:
198 Count.

Finished Case.



3-3 Pack, 216 Count.

Finished Case.



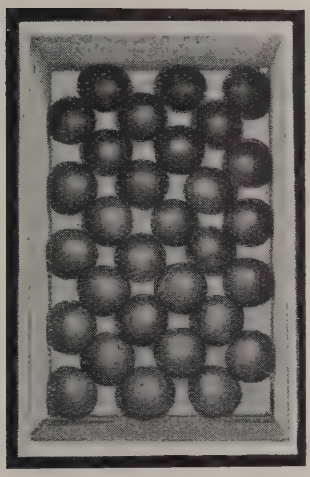
3-3 Pack, 198 Count.

Note the alignment of the fruit in the case.

PLATE 55.

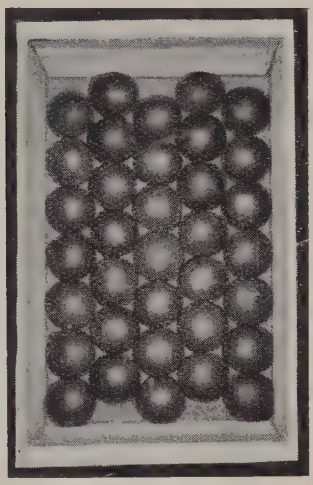
STANDARD CASE.

First Layer.
3-3 Pack.



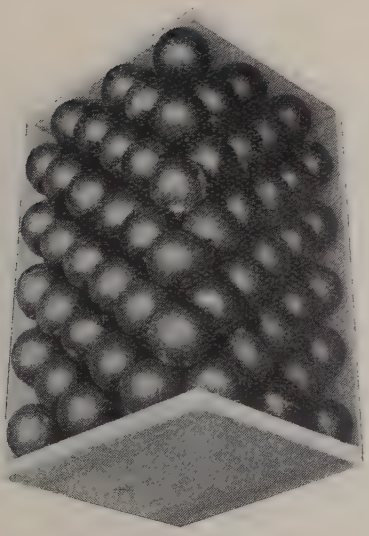
5 x 5 Layer Count, 6 Layers: total, 180.

First Layer.
3-2 Pack.



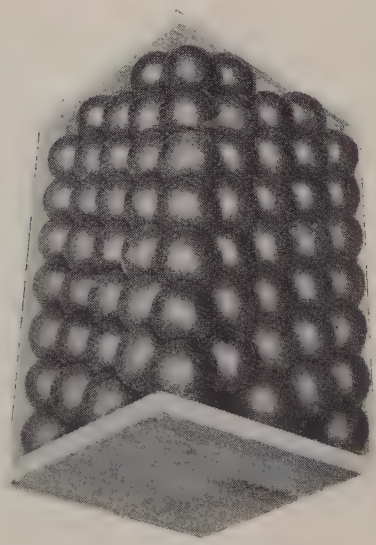
7 x 7 Layer Count, 5 Layers: total, 175.

Finished Case.



3-3 Pack, 180 Count.

Finished Case.



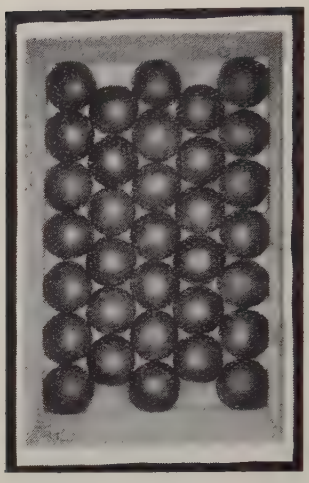
3-2 Pack, 175 Count.

Note the alignment of the fruit in the case.

PLATE 56.

STANDARD CASE.

First Layer.
3-2 Pack.

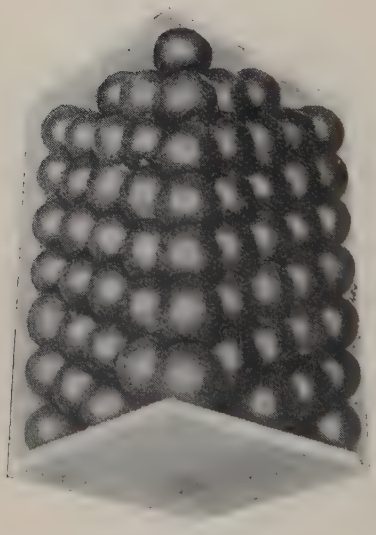


7 x 6 Layer Count, 5 Layers: total, 163.

First Layer.
3-2 Pack.

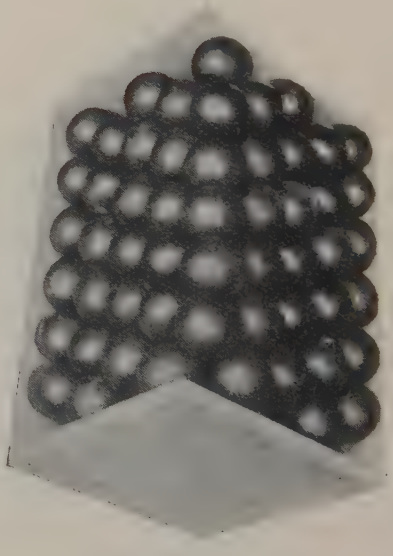
6 x 6 Layer Count, 5 Layers: total, 150.

Finished Case.



3-2 Pack, 163 Count.

Finished Case.



3-2 Pack, 150 Count.

Note the alignment of the fruit in the case.

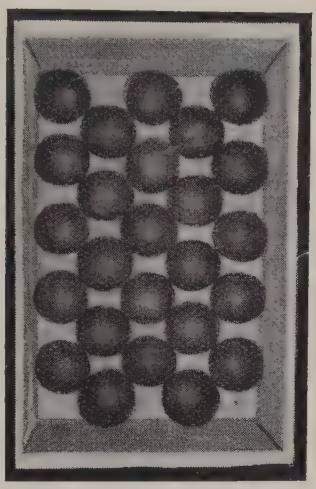
PLATE 57.

STANDARD CASE.

First Layer.
3-2 Pack.

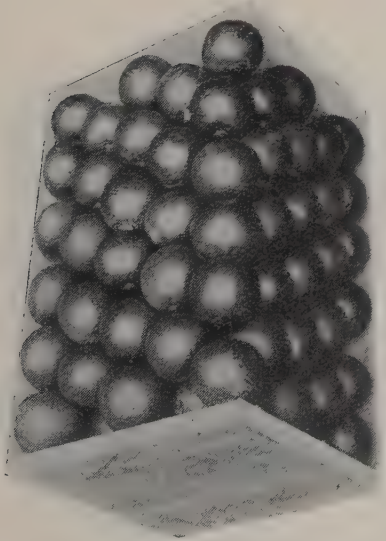
6 x 5 Layer Count, 5 Layers: total, 138.

First Layer.
3-2 Pack.



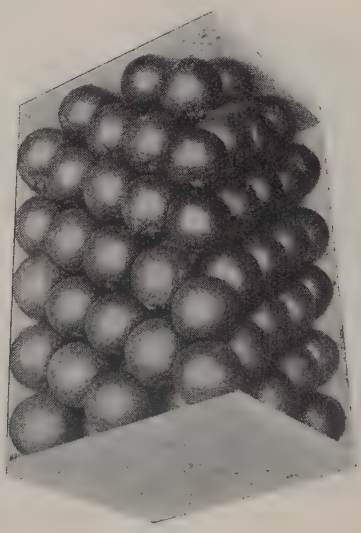
5 x 5 Layer Count, 5 Layers: total, 125.

Finished Case.



3-2 Pack, 138 Count.

Finished Case.



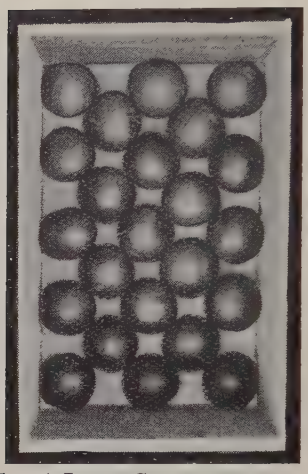
3-2 Pack, 125 Count.

Note the alignment of the fruit in the case.

PLATE 58.

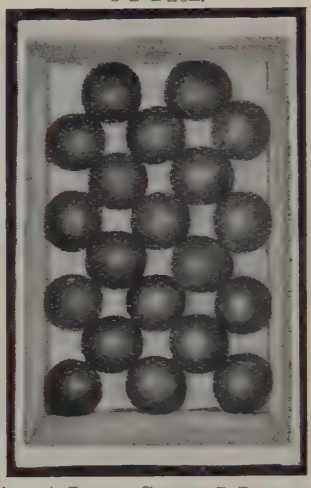
STANDARD CASE.

First Layer.
3-2 Pack.



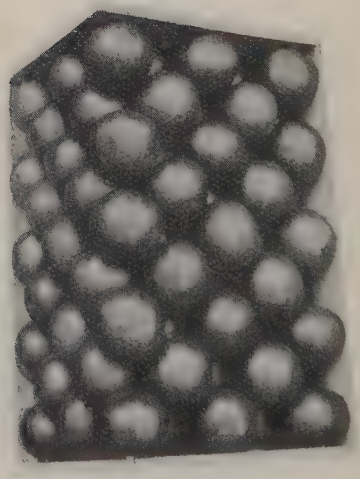
5 x 4 Layer Count, 5 Layers: total, 113.

First Layer.
3-2 Pack.



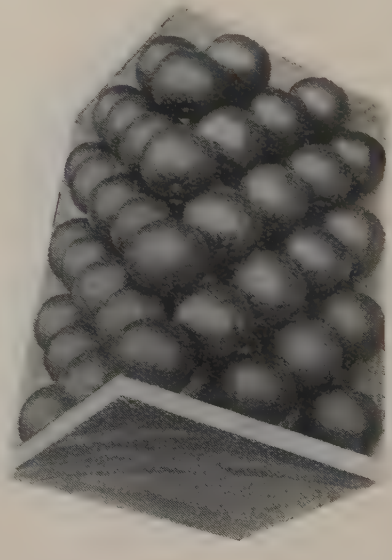
4 x 4 Layer Count, 5 Layers: total, 100.

Finished Case.



3-2 Pack, 113 Count.

Finished Case.



3-2 Pack, 100 Count.

Note the alignment of the fruit in the case.

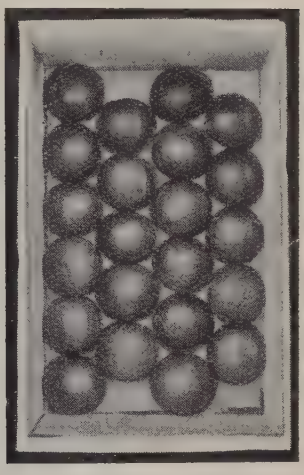
PLATE 59.

STANDARD CASE.

First Layer.
2-2 Pack.

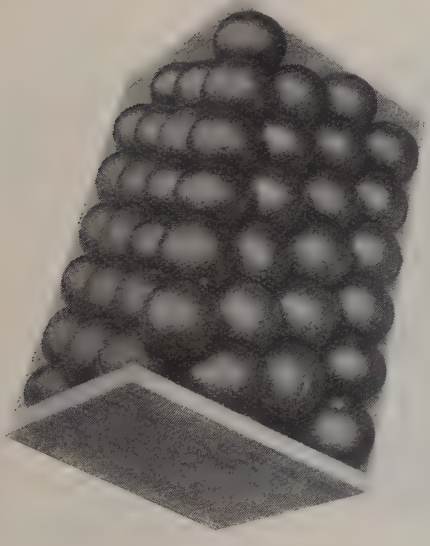
6 x 6 Layer, 4 Layers:
total, 96.

First Layer.
2-2 Pack.



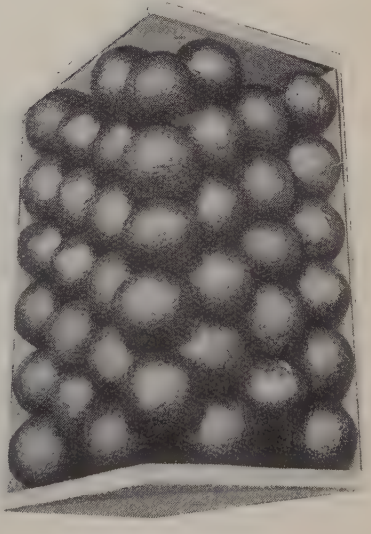
6 x 5 Layer, 4 Layers:
total, 88.

Finished Case.



2-2 Pack, 96 Count.

Finished Case.

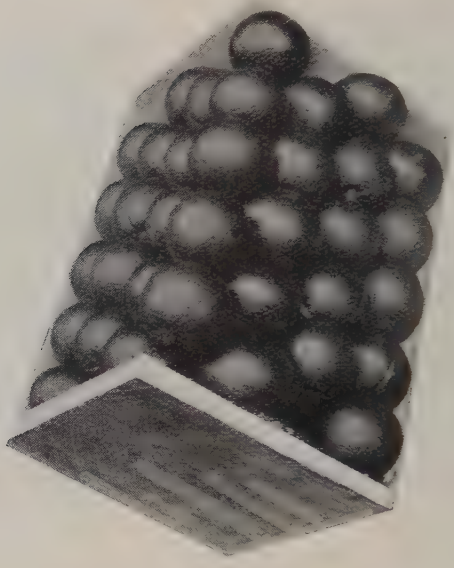


2-2 Pack, 88 Count.

Note the alignment of the fruit in the case.

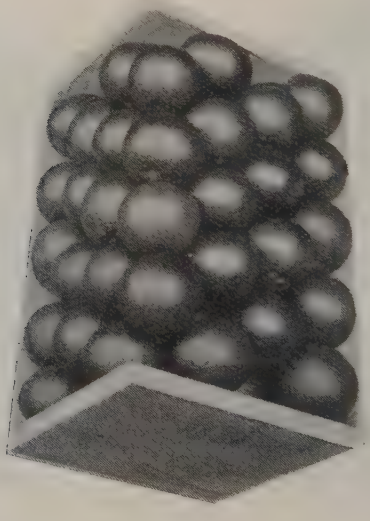
PLATE 60.

STANDARD CASE.
Finished Case.



2 2 Pack, 5 x 5 Layer. 4 Layers, 80 Count.

Finished Case.



2-2 Pack, 5 x 4 Layer. 4 Layers, 72 Count.

Note the alignment of the fruit in the case.

PLATE 61.

[TO BE CONTINUED.]

Casein as a Commercial Commodity.

THE manufacture of casein from skim milk and butter milk is an industry that has been carried on in other parts of the world for years. The importance of casein, particularly casein glue, was realised during the war, when it was used extensively in aeroplane construction, especially for plywood for fuselage coverings, and engine beds. Since the World War its manufacture has increased enormously owing to the increasing commercial application of this commodity.

It is difficult to keep pace with the march of casein into the commercial arena. It has entered the paper industry, where it is used for producing highly glossed surfaces on paper so essential for fine lithographic work. It is utilised extensively in glue preparations, supplanting many of the animal and other glues previously known. As a glue it is used in wood-working industries, such as motor-car body frames, pianos, furniture, doors, refrigerators, and numerous others.

In the realm of plastics its uses are increasing day by day, it being used as a substitute for horn, celluloid, bone, ivory, ebony, pearl, amber, and tortoise shell, and when we consider the vast number of beads, buttons, buckles, combs, cigarette holders, cuff links, electrical insulators, manicure and toilet sets, pen holders, fountain pen barrels, pencils, pipe stems, spectacle frames, &c., that are sold every day, some idea can be gleaned of the importance of casein in the plastic industry alone.

The articles already mentioned should suffice to establish its importance, but when we remember also that it is extensively used in such industries as paints, textiles, leathers, spreaders, and adhesives, foods, and medicine preparations, and such miscellaneous substances as face cream, pastes, shoe polish, insecticides, sprays, &c., so it is obvious that the possibilities of casein as a commercial commodity are enormous.

TO SUBSCRIBERS—IMPORTANT.

Several subscriptions have been received recently under cover of unsigned letters. Obviously, in the circumstances, it is impossible to send the Journal to the subscribers concerned.

It is most important that every subscriber's name and address should be written plainly, preferably in block letters, in order to avoid mistakes in addresses and delay in despatch.

Testing Acidity in Milk and Cream.

Material Required.

Decinormal caustic soda solution.

Phenol-phthalein solution (indicator).

(The above solutions should be prepared by a chemist.)

One pipette of 9, 10, or 17·6 c.c. or other stock size.

One white cup.

One 25 c.c. burette graduated to 0·1 c.c.

Distilled or rain water.

One glass stirring-rod.

Method of Making the Test.

1. First stir the cream or milk in order that a representative sample of the whole may be obtained.

2. Measure a sample of cream or milk into the cup. Rinse the pipette with distilled or rain water, and place the rinsings also in the cup.

3. Add three or four drops of indicator.

4. From the burette run the alkali solution into the mixture while constantly stirring it, and until it assumes a uniform faint pink tint. This is the end point of the test and all acid is neutralised.

Especial care should be taken at this point. If the colour does not disappear within thirty to sixty seconds after the completion of the test, too much alkali has been used, and an incorrect result will be obtained.

5. Note to 0·1 c.c. the quantity of alkali used.

Calculating the Result of the Test.

As 1 c.c. of the alkali solution exactly neutralises 0·009 grammes of lactic acid, the result may be obtained as follows:—

Multiply the number of c.c. of alkali used by 0·009, divide the result by the number of c.c. of the sample of cream or milk, and multiply this result by 100.

The method generally adopted in making this test in dairy factories in this State is similar to the above, but a 9 c.c. pipette is used, and the test result is read direct from the burette, each cubic c.c. of alkali used being calculated as 0·1 per cent. of acid; thus, if the amount of alkali used to neutralise 9 c.c. of milk or cream is 2·7 c.c., the acidity is 0·27 per cent.

This method is simple and quite satisfactory if care be taken to ensure accuracy in measuring the sample of milk or cream, the amount of alkali used, and in completing the test as indicated by the action of the colour changes abovementioned.

ACIDITY REDUCTION TABLE FOR CREAM.

Compiled by F. J. WATSON, Dairy Instructor.

Basis of Table:—·093 lb. soda bicarb. neutralises ·1 per cent. of acid in 100 lb. cream.

PERCENTAGE OF REDUCTION DESIRED.

..	·02	·04	·06	·08	·10	·12	·14	·16	·18	·20	·22	·24	·26	·28	·30	·32	·34	·36	·38	·40	·42	·44	..

BICARBONATE OF SODA REQUIRED IN POUNDS AND OUNCES.

lb. cream.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. cream.
50	0 0	0 0	0 0	0 0	0 0	0 1	0 1	0 1	0 1	0 1	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 3	0 3	0 3	0 3	0 3	50
100	0 0	0 0	0 1	0 1	0 1	0 2	0 2	0 2	0 3	0 3	0 3	0 4	0 4	0 4	0 4	0 5	0 5	0 5	0 6	0 6	0 6	0 7	100
200	0 0	0 1	0 2	0 2	0 3	0 4	0 4	0 5	0 6	0 6	0 7	0 7	0 8	0 8	0 9	0 10	0 10	0 11	0 11	0 12	0 12	0 13	200
300	0 1	0 2	0 3	0 4	0 4	0 5	0 6	0 7	0 8	0 9	0 10	0 11	0 12	0 13	0 13	0 14	0 15	1 0	1 1	1 2	1 3	1 4	300
400	0 1	0 2	0 4	0 5	0 6	0 7	0 8	0 10	0 11	0 12	0 13	0 14	0 15	1 1	1 2	1 3	1 4	1 5	1 7	1 8	1 9	1 10	400
500	0 1	0 3	0 4	0 6	0 7	0 9	0 10	0 12	0 13	0 15	1 0	1 2	1 3	1 5	1 6	1 8	1 9	1 11	1 12	1 14	1 15	2 1	500
600	0 2	0 4	0 5	0 7	0 9	0 11	0 12	0 14	1 0	1 2	1 4	1 5	1 7	1 9	1 11	1 13	1 14	2 0	2 2	2 4	2 5	2 7	600
700	0 2	0 4	0 6	0 8	0 10	0 12	0 15	1 1	1 3	1 5	1 7	1 9	1 11	1 13	1 15	2 1	2 3	2 5	2 8	2 10	2 12	2 14	700
800	0 2	0 5	0 7	0 9	0 12	0 14	1 1	1 3	1 5	1 8	1 10	1 13	1 15	2 1	2 4	2 6	2 8	2 11	2 13	3 0	3 2	3 4	800
900	0 3	0 5	0 8	0 11	0 13	1 0	1 3	1 5	1 8	1 11	1 13	2 0	2 3	2 5	2 8	2 11	2 14	3 0	3 3	3 6	3 8	3 11	900
1000	0 3	0 6	0 9	0 12	0 15	1 2	1 5	1 8	1 11	1 14	2 1	2 4	2 7	2 10	2 13	3 0	3 3	3 6	3 9	3 12	3 14	4 1	1000
2000	0 6	0 12	1 2	1 8	1 14	2 4	2 10	3 0	3 6	3 12	4 1	4 7	4 13	5 3	5 9	5 15	6 5	6 11	7 1	7 7	7 13	8 3	2000
3000	0 9	1 2	1 11	2 4	2 13	3 6	3 14	4 7	5 0	5 9	6 2	6 11	7 4	7 13	8 6	8 15	9 8	10 1	10 10	11 3	11 11	12 4	3000
4000	0 12	1 8	2 4	3 0	3 12	4 7	5 3	5 15	6 11	7 7	8 3	8 15	9 11	10 7	11 3	11 14	12 11	13 6	14 2	14 14	15 10	16 6	4000
5000	0 15	1 14	2 13	3 12	4 10	5 9	6 8	7 7	8 6	9 5	10 4	11 3	12 1	13 0	13 15	14 14	15 13	16 12	17 11	18 10	19 8	20 7	5000

The Velvet Bean.

By N. A. R. POLLOCK, H.D.A., Senior Instructor in Agriculture.

THE Podbearers, known as Velvet Beans, are grouped as species of the genus Stizolobium, syn. Mucuna, of the Natural Order Leguminosæ. They are recorded as natives of Tropical America, Asia, and Africa, with one from Fiji.[1]

As a farm crop the velvet bean is comparatively new, little attention having been devoted to it until within the last half-century. Prior to that the chief value of the genus was regarded as a source of the Cowhage or Cowitch of the materia medica, which was obtained from the species pruriens and prurita.

The name Velvet Bean is derived from the velvety feel and appearance of the pods, particularly those of the Florida species.

The genus comprises upward of twenty species, but only five have been deemed worthy of cultivation. These are the Lyon; Chinese; Yokohama, the pods of which are covered with short white or greyish hairs; Mauritius; and Florida, the pods of which are covered with short thick black velvety hairs.

There are at present a considerable number of varieties obtained by selection from species and their cross breeding. These vary in the colour of the flowers, length of pods, and colour of seeds, which may be white, brown, mottled, or black, as well as in their period of growth to maturity.

The best-known variety in Queensland is the Mauritius, which is largely grown in the canefields of the North for a green manure. This variety is probably of later-maturing habit than others, as it takes usually sixteen weeks to produce the first flowers and twenty-seven weeks to ripen the first pod. The seeds are shining black, rather flat, with a prominent white hilum, three to five being contained in a pod about 4 inches long.

The *Early Georgia*, a variety of the Florida species, is perhaps the earliest to mature, flowers forming in about eight weeks from germination of the seed and the first pods ripening in about nineteen weeks. The ripe pods are black, very hairy, 2 to 2½ inches long, and contain three or four seeds. The seeds, about the size of a marble, are oval or rounded, light in colour, with brownish black mottling.

The *Yokohama* is what may be termed of mid-season maturity, taking twelve weeks to flower and about twenty-two weeks to ripen the first pods. The pods are from 4 to 5 inches long, and contain usually five seeds of dull or greyish-white colour, flat, oblong, and often slightly depressed at the sides.

Early-maturing varieties are suggested in E. Georgia, Early Black, E. Arlington, Alabama, 100-day Speckled, &c.

Medium-maturing varieties are Yokohama, Lyon, and Chinese.

Late-maturing varieties are Mauritius and White Stingless.

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[1] Nicholson, Encyclopedia of Horticulture.

Climate.

The Velvet Bean being native of tropical latitudes can be expected to give the best return in the Northern parts of the State, but good yields may be expected during the summer in all parts when early maturing varieties are sown and sufficient rain falls to provide the necessary soil moisture. Being of comparatively long-season growth the seed of any variety should be sown early and as soon after danger from frost is past as possible, especially in cooler parts.

Soils.

The Velvet Bean will succeed on a wide range of soils from a coarse sand to a heavy clay loam, provided they are sufficiently well drained. The best growth can naturally be expected on a free-working fertile loam. Low-lying soils that are apt to become water-logged are not suited to the crop, as owing to the dense foliage produced the free circulation of air is not permitted, and rotting is likely to result.

Plate 62.
Early Georgia Velvet Beans, Tolga, ten weeks growth.

Uses.

Green Manure, being probably the most vigorous of all legumes cultivated, the volume of growth commends the Velvet Bean as a crop to be ploughed under as a green manure, to restore organic matter in the soil. In common with many other legumes, the nodules formed by the nitrogen-fixing bacteria are plentiful on the extensive root system, thus adding materially to its value in that respect.

Hay or Grazing.—The vines either green or cured as hay form a nutritious and palatable fodder for stock. In curing for hay the vines

must necessarily be cut by hand. Soon after the first flowers have formed is regarded as the best time, as the vines will then be less coarse. Shortly after wilting they should be put into cocks through which the air will readily circulate. As with other legumes the chief food value lies in the leaves, the retention of which is of major importance. In favourable weather, after the lapse of a few days the hay can be stacked, when, if the vines are not quite cured, a mild fermentation will perhaps render the vines more digestible or attractive as in brown lucerne hay. This fermentation, however, should not be sought, as it can go too far, and the aim should be to stack properly cured with a full retention of the leaves.

PLATE 63.
One Plant Early Georgie Velvet Bean, Tolga—ten weeks' growth.

Feeding-off.—The heavy yield of nutritious fodder renders the crop attractive for feeding-off, and excellent results, both in fattening and milk production, are reported from grazing cattle thereon. It also provides a profitable range for pigs. As the plants are of vigorous and long-continued growth, a daily period of grazing by dairy cows, with a final ploughing under as a green manure, should be profitable.

PLATE 64.
Velvet Beans, Toonpan, Townsville.

PLATE 65.
Velvet Beans growing amongst maize, Kairi, Atherton Tableland.

For Ensilage.—As an addition to maize or sorghum for ensilage, the Velvet Bean from its high protein content is of value. When grown conjointly the vines will climb the stalks, facilitating harvest. Grown in this manner also, the mixed crop has an added value when fed-off by pigs.

Seed.—The seeds form a valuable concentrate much relished by stock. Being usually as large or larger than a schoolboy's marble, farm animals can be expected to masticate them sufficiently for digestion. Crushing or grinding to a meal with or without the pod, which has some food value, however, is regarded as most economical. The green seeds, shelled as in the manner of Broad Beans or Lima Beans, are often esteemed for human consumption.

A heavier yield of seed is obtained when the plants are supported (see under "Cultivation.")

Cover Crop.—As a cover crop to keep down weeds, the heavy and long continued growth of the Velvet Bean commends it. When a field has become heavily weed-infested with growths hard to keep down or eradicate, the crop is of material advantage. It may be found of much value in this direction where the land is infested with Johnson grass.

Analyses.

From Henry and Morrison's "Feeds and Feeding," the following analyses are extracted to show the fodder value of the Velvet Bean:—

	Total Dry Matter in 100 Lb.	Digestible Nutrients in 100 Lb.				Nutritive Ratio.
		Crude Protein.	Carbo-hydrate.	Fat.	Total.	
Seed	88·3	18·1	50·8	5·3	80·8	1 : 3·5
Seed and Pod	87·7	14·9	51·7	3·8	75·3	1 : 4
Hay	92·8	12·0	40·3	1·4	55·5	1 : 3·6
Green Material ..	17·9	2·7	7·2	0·4	10·8	1 : 3

Cultivation.

The land should be ploughed at least 6 inches in depth—cross-ploughed if necessary—and harrowed to produce a good tilth, as with other crops.

The seed is usually sown singly at intervals of 1 foot or 18 inches apart, in drills 4 to 5 feet apart. Sometimes the seed is sown in hills 3 feet apart; 10 to 20 lb. are regarded as sufficient for an acre. Inter-row cultivation should be practised to keep down weeds until the vines spread, probably over a period of four weeks, when the crop will need no further attention.

When sown as a mixture with maize or sorghum for grazing-off or for silage, the seed may be sown in the drill at the same time or after the maize or sorghum has germinated. In tropical parts, where the cereal makes a more rapid growth, it is perhaps preferable to sow the velvet bean seed, at the same time spacing the seeds 3 or more feet

apart in the drill. In cooler parts, it is advised to sow after the cereal has germinated at the time of its first cultivation or within three weeks.

Where the yield of seed is important or where it is to be saved separately from the hay, growth on tripods is recommended. These tripods can be formed of bush poles, say, 10 feet long, loosely wired about 2 feet from the top, so that two legs will rest on one drill and the third on the next. Tripods should alternately face reverse directions, and should be erected when the vines are growing towards the centre of the rows, after some cultivation has been given.

Plate 66.
A Velvet Bean Crop in the Lower Burdekin District.

Grown on tripods, or in situations where the vines will be elevated, a very much greater yield of pods and seed will result. As much as double and treble such yield can be expected over plants running on the ground. Not only is the yield increased by growing on tripods, but the pods are much more easily harvested, since they will hang in bunches of as many as twenty or more, while those of prostrate growth will occur in much fewer numbers. Harvest of the vines, which have some value when the pods are removed, is facilitated when grown on the poles of the tripod, or they can be ploughed under when the poles are removed.

Yields.

The yield of vine growth will be determined by the soil and seasonal conditions and the period of growth, but 20 tons per acre of the green material in the case of the Mauritius variety is not unusual, and 10 tons or more per acre of the early-maturing sorts can be expected on reasonably fertile soil in a favourable season.

The yield of seed may be anything up to 30 bushels per acre with early-maturing varieties, or 50 bushels with medium and late maturing

kinds. When grown on tripods, however, the yield is much increased, and as many as 100 bushels per acre have been obtained in other countries.

The following yields were recorded in trials made some years ago in the Northern district:—

At Tolga—Early Georgia variety, 10 tons 18 cwt. per acre of green stuff when the first pods were setting.

At Millaa Millaa—Sown 2nd November, estimated 3rd March: Early Black, 18 tons per acre of green material; Early Georgia, 14 tons 9 cwt. per acre of green material; Mauritius, 11 tons 5 cwt. per acre of green material.

PLATE 67.
Velvet Beans, Lower Burdekin—a closer view of Plate 66.

Shelling the Seed.

While some of the varieties have thin pods, which readily break when dry to release the seed, others, such as the Mauritius, present thick hard shells, which are more difficult to treat.

Machinery to shell the seed is available, but in its absence it is advised to spread the pods exposed to the hot rays of the sun. When thoroughly dry a sprinkling with water from a hose or watering-can will cause the shells to shrink and burst open, thus releasing the seed.

For home use the whole pods can be ground, and the coarse part of the pods sifted out from the meal. Pigs have no trouble in shelling the pods, which should be fed to them whole.

Diseases.

The Velvet Beans appear to be remarkably free from disease, no instance of such having been recorded in the State, or as far as is known in other parts of the world.

Agricultural Notes.

By H. S. HUNTER, Agricultural Branch.

Crop Prospects.—The month of June yielded but little rainfall, and the consequential depreciation of the pastures, coupled with the cold weather, has been reflected in a falling-off in the output of dairy products. The paucity of the rainfall also has retarded the preparation of the land for fodder crops for early spring sowing. The decreased output on the dairy farms has been compensated for to some extent by improved values for commercial butter as a result of the operations of the Butter Stabilisation Scheme.

Sugar.—The past month was associated with cooler atmospheric conditions, and crop growth has been retarded in all areas as a consequence. The season is one in which a high degree of flowering is being experienced. This means that further growth will not be possible, and a continuance of moist conditions will be necessary to ensure the absence of over-maturity before harvesting.

Plate 68.—On the Road to Rosewood.

From a point near Minden, overlooking the rich farming lands of Marburg. Red and cocoa-coloured soils, covered originally by dense vine jungle, are characteristic of the Rosewood district, one of the most productive provinces in the State. This country has emerged from untrodden jungle to its present intensity of agricultural development in the short span of a single generation of Queensland pioneers.

Early reports from those mills which have commenced crushing operations suggest that the cane is of high sugar content this year, and on the preliminary estimates there is every probability that the sugar tonnage which will be produced will fall little below that of 1933.

Wheat.—The lack of rain has been felt particularly in the farming districts beyond the Range. The precipitations which were received at the end of the month over a large portion of the wheatgrowing area were generally of a light nature and only sufficient to freshen up the growing crops. Except on areas which had received an early cultivation and

where good bottom moisture was present in the soil the fall on the whole was insufficient to permit of completing the main sowing.

In the Maranoa the dry spell has been of longer duration, practically no rain having fallen in May and, in addition, the district has been invaded by a plague of grasshoppers which has caused considerable damage to young seedling wheat. The greater part of the Maranoa wheat area, however, still remains unsown.

Canary Seed.—Other States of the Commonwealth, particularly South Australia and Western Australia, now are giving attention to the cultivation of canary seed, and as the market for this grain is limited Queensland growers have been warned of the dangers of overproduction. It has been estimated that States other than Queensland will harvest 500 tons of canary seed this year.

PLATE 69.—FERTILE FARMING LANDS IN SOUTHERN QUEENSLAND.
Looking towards Marburg from Minden.

Maize.—Harvesting of the late crop is now being carried out and, with the exception of some of the more inland districts where yields are light owing to dry conditions fairly good results are being obtained.

Large quantities are being held on the farms awaiting an improvement in the price.

Cotton.—The killing frosts commencing in mid-June have hastened the opening of the top bolls, thus allowing of the completion of the harvesting which is required in order to enable new crop preparations to start.

Owing to the completion of the first picking and the consequent lessening of pressure of receivals at the ginneries the Gladstone plant was closed on the 15th June. The Glenmore and Whinstanes plants are still operating busily with prospects of continuing for a couple of months, for a big top crop still remains to be harvested.

The ginnings to the 22nd June total 12,289 bales of lint, which is a record for the State, the individual ginnery outputs being: Glenmore, 6,130 bales; Gladstone, 2,170; and Whinstanes, 3,989.

Tobacco.—Harvesting now has been completed in areas subject to frost, and although in the frost-free districts of the North leaf is still being harvested, the cold weather has retarded the ripening of the leaf and, as a result, curing troubles are being experienced.

Plate 70.—A Halt on the Highway to the Darling Downs.
The country around Marburg, a district of comfortable homesteads, fertile fields, and agricultural abundance.

Tobacco growers are busily engaged in the grading of the leaf, uprooting and destruction of old plants to eliminate breeding grounds for pests and diseases, and in ploughing operations to permit of the land lying fallow until next planting season.

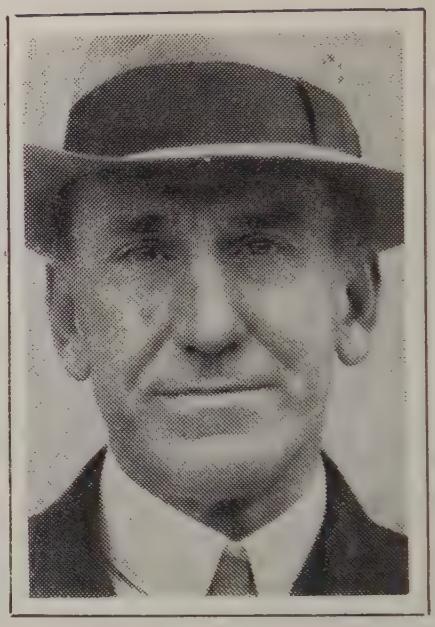
Melbourne Centenary Celebrations.—A display representative of Queensland's primary industries is to be staged in Melbourne for the Centenary Celebrations. The exhibit is to include wool, cotton, cereals, tobacco, and fruits. Tropical fruits such as pineapples, bananas, and pawpaws are to be featured, and an endeavour will be made to include plants bearing the different fruits.

The display is to be housed in the Melbourne offices of the Queensland Tourist Bureau.

LOSSES CAUSED BY SOIL EROSION.

The enormous economic losses caused by soil erosion in the United States of America are described by Mr. H. H. Bennett in "The Ohio Journal of Science." Mr. Bennett states that more than 100 million acres of the 350 million in cultivation in the United States have lost all or most of the precious material called top soil. At least 160 million acres of the remainder are suffering in some degree. To date, the essential destruction of about 35 million acres of what formerly was largely good crop land, together with an enormous additional area of grazing land, has been permitted. The land has been so deeply washed, so cut to pieces by gullying, or so smothered with the products of erosion that it cannot be reclaimed upon any practical basis by the average farmer. Much of it is permanently destroyed. Bedrock has been reached in countless places and deep gullies have torn asunder millions of sloping acres. All of this has been abandoned.

In Memoriam.



Mr. W. H. AUSTIN.

BY the death of Mr. W. H. Austin, Under Secretary of the Department of Labour and Industry, on 26th May, Queensland lost a distinguished public servant. No finer tribute could be paid to the memory of a public official than the statement of the Deputy Premier of the State that the late Mr. Austin exhausted himself in the conscientious discharge of duties.

The late Mr. Austin, who was 59 years of age, was one of the State's most valued servants, and his death came as a great shock to the Government and his friends. Mr. Austin was educated at the Normal School and later at the Brisbane Grammar School, of whose Old Boys' Association he was a past president. After a period with Messrs. Finney, Isles, and Co., Ltd., he entered the Government Savings Bank in 1892 and later was transferred to the Auditor-General's Department. In 1918 he became Deputy Auditor-General. At the end of that year he was appointed Commissioner of Trade in charge of State Enterprises, and subsequently combined these duties with that of Under Secretary of the Department of Labour and Industry. At the Labour Department Mr. Austin had a big task in dealing with the unemployment position. He personally interested himself in the many details associated with the settlement of unemployed families on group settlement schemes at Nerang, Mudgeeraba, Beerburrum, and in other areas on the North Coast. He was a most humane man in all his dealings with the unemployed and their difficulties.

Mr. Austin served on various important Commissions of Inquiry, notably that which sought information about the Beef Cattle Industry a few years ago. Recently he was a member of the Queensland Trade Delegation to the East. He was also a member of the Bureau of Industry. During the last two weeks preceding his death he put into operation the machinery for the distribution of winter relief to the unemployed and their families, and at the time of his death he was engaged in the preparation of a programme for the expenditure of loan money in reproductive and necessary works throughout the State, so as to provide employment.

He had a very fine personality, and he carried with him the unmistakable mark of the sportsman and athlete. Such attributes should have preserved him for many more years of usefulness for the State, but he was quite unsparing of his physical reserves and has passed away at an age when his experience and judgment were at their maturity.

In his earlier days he was one of the finest Rugby Union footballers in Queensland. He played with the City and South Brisbane teams, and represented Queensland against New South Wales in 1895, 1896, 1898, 1899, 1901, against New Zealand in 1896 and 1897, and against Great Britain in 1899. He was captain of the Queensland team in 1898. He also played cricket in his youth, and in 1894 he captained a Queensland junior cricket team against the mother State. In later years he was a prominent bowler.

Mr. Austin is survived by his widow and four sons. They are Messrs. W. T. (Sydney), A. J., C. G., and J. D. Austin, to whom deepest sympathy is extended.

TRIBUTES.

The Acting Premier (Hon. P. Pease) said he was satisfied that work and worry over the relief of unemployment contributed to Mr. Austin's untimely death. Mr. Pease paid a tribute to the great work accomplished by Mr. Austin and to his splendid character.

The Minister for Labour and Industry (Hon. M. P. Hynes) said that Mr. Austin's sympathetic handling of relief matters won for him a host of friends among the unemployed. Mr. Austin's death left a great gap in the Public Service which would be hard to fill.

The Leader of the Opposition (Hon. A. E. Moore) said that Mr. Austin was one of those super-conscientious men who spent his whole energies in his work. Mr. Austin really tried to do too much. He was one of the finest senior officers in the Public Service.

Mr. S. Winders (Mayor of Coolangatta), referring to Mr. Austin's death, said that the local authorities throughout Queensland working on the intermittent relief labour scheme had lost an invaluable adviser, whose co-operation in relieving unemployment would be sadly missed. The relief workers throughout the State owed a debt of gratitude to Mr. Austin, whose sympathetic handling of the difficult problems had assisted materially in alleviating distress and placing men in work.

A kindly and courteous public officer, he had rendered outstanding service to the State and to the local government bodies.

The Nerang Shire Council has been advised by the Department of Public Instruction that the new State school at the Mudgeeraba Banana Settlement has been named Austinville after the late Mr. Austin, who was mainly responsible for the control of the intermittent labour section of the department's activities.

The late Mr. Austin was laid to rest in the Toowong Cemetery on Monday, 28th May, in the presence of a vast gathering representative of the Government, Parliament, Public Service, Commerce, Industry, and numerous sporting organisations.

Land for Grazing Selection.

ELDERSLIE RESUMPTION.

A SUBDIVISION of Elderslie Resumption, situated about 28 miles westerly from Winton, will be opened for grazing homestead selection at the Land Office, Winton, on Tuesday, 21st August. The area of the block is 25,400 acres. The land will be opened for a term of lease of twenty-eight years at an annual rental of 1¾d. per acre for the first seven years of the term.

The whole area is very open to lightly-shaded downs with small patches of stony hills. It is artificially watered by an artesian bore fitted with a pumping plant and mill, and by a sub-artesian bore fully equipped with a pumping plant. These supplies are sufficient.

Other improvements include boundary netting and wire fencing and intersecting wire fencing, paddocks, huts, shed, yards, spraying race, &c., valued provisionally at about £3,000.

The selection will require to be stocked to its reasonable carrying capacity with the applicant's own sheep within a period of three years, and proof must be furnished of the financial standing and pastoral or land experience of the applicants.

The existing marsupial netting fencing will require to be maintained marsupial-proof throughout the term of lease.

Free lithographs and full particulars may be obtained from the Land Agents, Longreach and Winton; the Land Settlement Inquiry Office, Brisbane; and the Government Intelligence and Tourist Bureaux, Sydney and Melbourne.

PLATE 71.

Lake Manchester, near Brisbane, Queensland.

PLATE 72.—BRISBANE GRAMMAR SCHOOL GROUP.

On the occasion of an instructional visit of the boys to the Laboratories of the Department of Agriculture and Stock on 25th May, under the guidance of Mr. Dakin (seated in the centre), of the B.G.S. Teaching Staff.

PRODUCTION RECORDING.

List of cows and heifers officially tested by officers of the Department of Agriculture and Stock which have qualified for entry into the Advanced Register of the Herd Book of the Australian Illawarra Shorthorn Society, the Jersey Cattle Society, and the Guernsey Cattle Society, production charts for which were compiled for the month of May, 1934 (273 days unless otherwise stated).

Name of Cow.	Owner.	Milk Production.	Butter Fat.	Sire.
		Lb.	Lb.	
AUSTRALIAN ILLAWARRA SHORTHORN.				
Mature Cow (over 5 Years), Standard 350 Lb.				
Evelyn of Sunnyview	J. Phillips, Wondai	22,575·07	904·236	Diamond of Greyleigh
Princess V. of Cascade	C. O'Sullivan, Greenmount	12,897	463·449	Royal Rupert of Cascade
Pearl 6th of Quarnlea	Lehfeldt Brothers, Kalapa	12,932·78	454·16	Colonel of Blacklands
Rosebud of Happy Valley	R. R. Radel, Coalstoun Lakes	8,611·6	365·714	Mollys Hero of Glenthorn
Eva 12th of Quarnlea (261 days)	Lehfeldt Brothers, Kalapa	10,779·39	360·279	Fairplay of Burradale
Violet of Happy Valley	R. R. Radel, Coalstoun Lakes	8,088	357·104	Chief of Hillview
Senior, 4 Years Old, Standard 330 Lb.				
Primrose 8th of Quarnlea	Lehfeldt Brothers, Kalapa	9,431·7	343·323	Nuggets Lad of Hillview
Happy Valley Belles Molly	R. R. Radel, Coalstoun Lakes	7,734·9	332·812	Mollys Hero of Glenthorn
Villa Maria Reddy 6th	J. Buckley, Ross Hill	7,565·5	332·528	Villa Maria Sarsfield
Junior, 4 Years Old, Standard 310 Lb.				
Pearl 17th of Quarnlea	Lehfeldt Brothers, Kalapa	8,752·48	385·177	Nuggets Lad of Hillview
Victory of Cedar Grove	A. C. Stewart, Coondoo	6,425·8	331·587	Mabel 2nd Victor of Coral Grange
Mountain Home Gem 6th	N. C. Lester, Laidley Creek West	8,295·56	328·172	Headlight of Greyleigh
Senior, 3 Years Old, Standard 290 Lb.				
Ashdale Daisy	A. Frank, Boonah	12,324·3	541·895	Diamond of Greyleigh
Junior, 3 Years Old, Standard 270 Lb.				
Morden Sparkle	R. Mears, Toogoolwaah	12,671·05	541·266	George of Nestles
Miss Vesta II. of Blacklands	S. L. Holmes, Goomburra	7,880·5	305·126	Red Prince of Blacklands
Tottie 13th of Yaralla	H. Embrey, Rosewood	6,392	300·424	Southern Cross of Raleigh

SENIOR, 2 YEARS OLD, STANDARD 250 LB.				
Lynthorne Betty (268 days)	G. A. Meyers Imbil	9,257·45	419·252	Plumstone of Blacklands
Lynthorne Peggy	G. A. Meyers, Imbil	8,362·15	365 437	Plumstone of Blacklands
Lynthorne Ida	G. A. Meyers, Imbil	8,999·25	361·757	Plumstone of Blacklands
Eva's Pride of Quarnlea (262 days)	Lehfeldt Brothers, Kalapa	8,697·23	323·47	Nuggets Lad of Hillview
Lynfield Success V.	V. Dunstan, Wolvi	7,651·55	309·811	Lavenders Pride of Blacklands
Lady Sal XIII. of Cedar Grove	A. C. Stewart, Coondoo	7,040·95	301·669	Duke of Cedar Grove
Navillus Mavis	C. O'Sullivan, Greenmount	6,904·75	285·403	Midgets Sheik of Westbrook
Glen Sally	A. C. Stewart, Coondoo	6,518·05	266·772	Lorna's General of Arley
JUNIOR, 2 YEARS OLD, STANDARD 230 LB.				
Star 2nd of Alfa Vale	W. H. Thompson, Nanango	10,922·95	436·685	Reward of Fairfield
Mabreen Tottie	V. Dunstan, Wolvi	9,308·25	357·182	Numbawarra Headlight
Rhodesview Nancy 6th	D. Gierkie and Sons, Helidon	8,631·25	347·229	Blacklands Prospector
Broady 7th of Villa Maria	S. L. Holmes, Goomburra	7,741·82	333·231	Greymare Gay Lad
Laguna Venus	F. G. Lamkin, Kaimkillenbun	7,982·86	320·773	Fuchsias Monarch of Rosenthal
Cedargrove Gusty 2nd	P. D. Fiechtner, Greenmount	7,140·15	307·489	Duke of Cedar Grove
Cedargrove Lady Prim 11th	P. D. Fiechtner, Greenmount	7,486·93	306·027	Duke of Cedar Grove
Rosenthal Lilac 4th	S. Mitchell, Warwick	6,765·75	292·227	Vain Prince
Navillus Olive 3rd	C. O'Sullivan, Greenmount	7,099·92	283·383	Midgets Sheik of Westbrook
Ashdace Lady Diana	A. Frank, Boonah	8,305·65	282·08	Red Knight of Kelston
Cedargrove Reddy 6th	P. D. Feichtner, Greenmount	6,409·88	281·412	Duke of Cedargrove
Cedargrove Iris	P. D. Feichtner, Greenmount	6,778·08	279·749	Duke of Cedargrove
Cedargrove Venus 6th	P. D. Feichtner, Greenmount	6,899·96	274·872	Duke of Cedargrove
Cedargrove Reddy 7th	P. D. Feichtner, Greenmount	6,443·6	268·164	Duke of Cedargrove
Daisy of Lynfield	F. E. Birt, Sexton	6,969·9	263·013	Lavenders Pride of Blacklands
Cedargrove Rosina II.	P. D. Feichtner, Greenmount	6,274·62	260·676	Duke of Cedargrove
Molly Belle of Happy Valley	R. R. Radel, Coalstoun Lakes	5,830·35	254·134	Venture of Happy Valley
Jubilee B of Rosenthal	F. G. Lamkin, Kaimkillenbun	5,798·64	253·82	Rosenthal Handsome Boy
Primrose VII. of Glenthorn	S. L. Holmes, Goomburra	6,683·24	246·479	Shamrocks Triumph of Burradale
Happy Valley Annie 5th	R. R. Radel, Coalstoun Lakes	5,318·55	240·691	Venture of Happy Valley

Production Recording—*continued.*

Name of Cow.	Owner.	Milk Production.	Butter Fat.	Sire.
	JERSEY.			
	MATURE COW (OVER 5 YEARS), STANDARD 350 LB.			
Trecarne Rosella	T. A. Petherick, Lockyer	9,613·32	601·243	Trinity Officer
Pineview Lucy	J. Hunter and Sons, Borallon	10,175·55	576·135	Carnation Lad
Trecarne Empress II.	R. A. Slaughter, Clifton	7,066·4	3[illegible]5·971	Carnation Royal Scot
Seycombe Gladness	C. Seymour, Coalstoun Lakes	5,874·4	356·569	Carnation Royal
	SENIOR, 4 YEARS OLD, STANDARD 330 LB.			
Pineview Model	J. Hunter and Sons, Borallon	9,951·3	620·592	Pineview Noble Lad
Ruth of Ipsley (365 days)	J. A. Rudd, Yeerongpilly	9,1[illegible]3·66	539·304	Rhuban of Ipsley
Oxford Graceful	F. Nimmo, Rosewood	7,088	388·546	Trinity Ambassador
	SENIOR, 3 YEARS, STANDARD 310 LB.			
Lavender of Calton	J. Collins, Tingoora	12,105·97	605·795	Prince Clare of Calton
	JUNIOR, 3 YEARS, STANDARD 270 LB.			
Pineview Noble Buttercup	J. Hunter and Sons, Borallon	7,454·04	449·223	Oxford Buttercups Noble
Trecarne Coronation	D. R. Hutton, Cunningham	7,178·6	410·87	Trecarne Golden King
Eldon Lavender	J. B. Keys, Gowrie Little Plains	7,408·78	384·373	Retford Raleighs Chief
Glenview Springfield	F. P. Fowler and Sons, Coalstoun Lakes	5,818·5	336·13	Carlisle Larkspur 2nd Empire
Creamys Lady of Inverlaw	R. J. Crawford, Inverlaw	5,304·05	303·968	Bruce of Inverlaw
	SENIOR, 2 YEARS, STANDARD 250 LB.			
Oxford Astor Daisy	E. Burton and Sons, Wanora	7,568·83	510·208	Trinity Ambassador
Ripple of Ipsley	J. A. Rudd, Yeerongpilly	4,759·24	296·699	Ray of Ipsley
Seycombe Granny	C. Seymour, Coalstoun Lakes	3,994·75	250·918	Carnation Prince Charles
Overlook Remus Fawn	E. Burton and Sons, Wanora	6,995·25	400·055	Overlook Favourite Remus
Oxford Queen Daffodil	E. Burton and Sons, Wanora	6,224·55	374·495	Trinity Ambassador

College Fleur	Queensland Agricultural High School and College, Gatton	6,069·22	309·245	Burnside Defender
Trecarne Jersey Queen	T. A. Petherick, Lockyer	5,685·54	329·395	Trecarne Golden King
Pineview Lexie	J. Hunter and Sons, Borallon	5,461·85	314·203	Oxford Buttercups Noble
College Mildred	Queensland Agricuturlal High School and College, Gatton	5,691·18	305·956	Burnside Renown
Newhills Sirus	J. Nicol Robinson, Maleny	4,656·75	303·405	President of Brooklodge
Irene's Joyce of Wattle View	E. C. Groves, Kandanga	4,470·1	284·243	Prince Royal of Wattle View
Bellgarth Birthday	D. R. Hutton, Cunningham	5,270·5	279·963	Bellefaire, Blondes Bellringer
Glenview Hazel	F. P. Fowler and Sons, Coalstoun Lakes	4,611·05	277·535	Trinity Officer
Trecarne Rosella 6th	T. A. Petherick, Lockyer	4,489·57	261·448	Trecarne Golden King
College Dina	Queensland Agricultural High School and College, Gatton	4,672·17	260·300	Burnside Renown
Bellgarth Dawn	D. R. Hutton, Cunningham	5,212·5	252·322	Bellfaire Blondes Bellringer
Trecarne Sweetheart	T. A. Petherick, Lockyer	4,220·06	238·995	Trecarne Renown

GUERNSEY.

SENIOR, 2 YEARS OLD, STANDARD 250 LB.

Linwood Betsy	A. S. Cooke, Maleny	5,508·6	285·232	Caramana Barrister
East Glyn Ballet Girl	A. S. Cooke, Maleny	4,510·7	250·327	Caramana Prince
Laureldale Beatrix	W. A. Cooke, Maleny	5,250·5	248·784	Moonji Naughty Boy

AGRICULTURE ON THE AIR.

Radio Lectures on Rural Subjects.

Arrangements have been completed with the Australian Broadcasting Commission for the regular delivery of further radio lectures from Station 4QG, Brisbane, by officers of the Department of Agriculture and Stock.

On Tuesdays and Thursdays of each week, as from the 3rd July, 1934, a fifteen minutes' talk, commencing at 7.15 p.m., will be given on subjects of especial interest to farmers.

Following is the list of lectures for July, August, and September, 1934:—

SCHEDULE OF LECTURES.

BY OFFICERS OF THE DEPARTMENT OF AGRICULTURE AND STOCK, RADIO STATION 4QG, BRISBANE (AUSTRALIAN BROADCASTING COMMISSION).

Tuesday, 10th July, 1934—"Preparing Pigs for Show." By L. A. Downey, Instructor in Pig Raising.

Thursday, 12th July, 1934—"The Principles and Practice of Pig Feeding. By L. A. Downey, Instructor in Pig Raising.

Tuesday, 17th July, 1934—"Plants Poisonous to Stock." By C. T. White, Government Botanist.

Thursday, 19th July, 1934—"Plants Poisonous to Stock." By C. T. White, Government Botanist.

Tuesday, 24th July, 1934—"A Ramble in Rural England and its Lessons." By J. F. F. Reid, Editor of Publications.

Thursday, 26th July, 1934—"An Excursion to Scotland—Livestock Studies." By J. F. F. Reid, Editor of Publications.

Tuesday, 31st July, 1934—"Queensland—A Fruitful Country." By J. F. F. Reid, Editor of Publications.

Thursday, 2nd August, 1934—"The Story of Butter and Cheese throughout the Ages." By O. St. J. Kent, B.Sc., Analyst.

Tuesday, 7th August, 1934—"The Packing and Preparation of Tomatoes for Market." By J. H. Gregory, Packing Instructor.

Thursday, 9th August, 1934—"The Avocado in Queensland and Elsewhere." By H. Barnes, Director of Fruit Culture.

Tuesday, 14th August, 1934—"Packing Shed Hygiene." By J. H. Gregory, Packing Instructor.

Thursday, 16th August, 1934—"The Importance of Citrus Bud Selection." By H. Barnes, Director of Fruit Culture.

Tuesday, 21st August, 1934—"Papaw Cultivation." By H. Barnes, Director of Fruit Culture.

Thursday, 23rd August, 1934—"The Pasteurisation of Milk and its Products." By O. St. J. Kent, B.Sc., Analyst.

Tuesday, 28th August, 1934—"Vitamins in Dairy Products." By O. St. J. Kent, B.Sc., Analyst.

Thursday, 30th August, 1934—"Factors Influencing the Amount of Fat in Milk." By O. St. J. Kent, B.Sc., Analyst.

Tuesday, 4th September, 1934—"Seasonal Farm Crops," Part I. By C. J. McKeon, Instructor in Agriculture.

Thursday, 6th September, 1934—"Seasonal Farm Crops," Part II. By C. J. McKeon, Instructor in Agriculture.

Tuesday, 11th September, 1934—"Seasonal Farm Crops," Part III. By C. J. McKeon, Instructor in Agriculture.

Thursday, 13th September, 1934—"The Tobacco Industry Protection Act of 1933." By H. S. Hunter.

Tuesday, 18th September, 1934—"Some Requirements of Plant Growth." By E. H. Gurney, Agricultural Chemist.

Thursday, 20th September, 1934—"Fertilizers and Manures." By E. H. Gurney, Agricultural Chemist.

Tuesday, 25th September, 1934—"Nutritive Value of Pasture." By E. H. Gurney, Agricultural Chemist.

Thursday, 27th September, 1934—"Mineral Ingredients in Stock Foods." By E. H. Gurney, Agricultural Chemist.

Answers to Correspondents.

BOTANY.

Replies selected from the outgoing mail of the Government Botanist, Mr. Cyril T. White, F.L.S.

Red Natal Grass.

E.A.T. (Stanthorpe)—

The specimen is *Rhynchylcytrum roseum* (Red Natal Grass). This grass is very common in many parts of Queensland, particularly in the coastal belt, where it is very abundant along railway cuttings, in pineapple and banana plantations, and, in fact, anywhere where the ground has been disturbed. It is not a particularly valuable grass for grazing, but is much used mixed with more palatable fodder as a chop-chop for working horses. It has a very light hold of the ground, and is eeasily pulled up by stock.

Berrigan.

M.M.K. (Springsure)—

The specimen is the Berrigan (*Eremophila longifolia*), a small tree or shrub, a native of Western Queensland and New South Wales. It should make an excellent garden shrub for dry places as it seems to stand dry weather remarkably well. The plant is quite a good fodder, and chemical analysis shows its nutritive value to be fairly high. In rabbit-infested areas it is said to be very hard to grow the shrub owing to the ravages of rabbits, which are exceedingly fond of the bark of this tree. Mr. Fred Turner, the well-known authority on grasses and fodder plants, in one of his books says that in certain parts of New South Wales large numbers of shrubs have been destroyed by rabbits eating the bark a few feet up the stems from the base. We were very interested to learn that the plant had transplanted so well, as it has generally been regarded as somewhat difficult to transplant. We are very keen on seeing the native trees and shrubs used more extensively for private and garden planting.

"Wild Lucerne."

J.W.H. (Caboolture)—

This plant first made its appearance in North Queensland a little over twenty years ago, but is reported to have been in the Northern Territory before that. It is now very abundant both in many parts of Queensland and the Northern Territory. Its botanical name is *Stylosanthes sundaica*, although it has previously gone under various names in Queensland—e.g., *Stylosanthes mucronata* and *Stylosanthes procumbens*. We think there is little doubt that where it has been introduced it has definitely increased the carrying capacity of the land. Its only drawback is that it is an annual. It generally germinates with the early summer rains, and is in full growth in January and February, but as far as we have observed stock do not care for it in its very green and luscious state, eating it very readily when it is drying off somewhat. This is rather a valuable feature, as the plant is dying off in the late summer and early autumn when other food is rather scarce. Experienced stockowners have told us that all classes of stock will lick up broken pieces of the dried plant in somewhat the same way as the Flinders Grasses. Chemical analysis carried out at the Agricultural Chemist's laboratory, Brisbane, shows the plant to approximate ordinary lucerne in nutritive value. As far as Australia is concerned, the plant was first recorded from the neighbourhood of Townsville, where it was looked upon as a weed of lawns, and hence is frequently known as Townsville Lucerne. It has been thought by some people that it may injure the native grasses by dying out and leaving bare patches, but as far as our experience goes this plant and the grasses seem to grow quite well together.

Emu Grass ("Dalby Wild Lucerne").

R.S. (Dalby)—

The specimen of "Dalby Wild Lucerne" has been determined as *Psoralea tenax*. This is a leguminous plant and is sometimes called Emu Grass. It is a native plant with a good reputation for fodder value.

Night Shade.

G.R.I.A. (Gympie)—

The specimen from Kilkivan has been identified as the Garden Night Shade (*Solanum nigrum*). It is widely spread over the warmer temperate regions of the world, and is a very common farm and garden weed in Queensland. The ripe berries are eaten by children, often in quite large quantities, without any ill effects. They are also commonly cooked for pies under the familiar name of blackberries, although, of course, they are quite distinct from the true blackberries of Europe and North America. The berries when green, however, are decidedly poisonous, and this applies, no doubt, to the other green parts of the plant. On this account the plant should be destroyed. Cases of poisoning in live stock are rare, and we were surprised to learn that the cattle had been eating it, for on the whole it is a plant rather rejected by them. The symptoms given are stupefaction, staggering, loss of feeling of consciousness, cramps, and sometimes convulsions. As in respect of many other plants of the Solanum family, or *Solanaceæ*, the pupils of the eyes of affected animals are generally dilated. The poisonous principle is an alkaloid Solanine. The eradication of the plant is recommended.

Groundsel Bush.

J.R. (Yeerongpilly)—

The specimen from Gympie has been determined as *Baccharis halimifolia*, the Groundsel Bush, a native of South America, and now a very common naturalised weed in Queensland. It has overrun many farms on the North Coast line, particularly towards the coast, on land that is sometimes subject to inundation. It is, however, not confined to such places, for we have had specimens from scrub farms on the Blackall and D'Aguilar Ranges. It is sometimes called Arsenic Bush, a name applied rather indiscriminately to some plants in Queensland, and this name does not seem justified. As some members of the genus have been suspected of poisoning stock in South America, feeding tests were carried out with this plant at Yeerongpilly some years ago, and after ten days to a fortnight's feeding the heifers were very thin and emaciated, but recovered when put back on to ordinary food. We should certainly say these heifers ate more of the plant than they would under natural conditions. From this it would seem that the plant has no fodder value, but is not poisonous. Some farmers on swampy coastal country in the neighbourhood of Noosa have told us that stock will browse on the plant, especially in drought time, and they have not noticed any ill effects from it.

A Common Weed (*Phaseolus lathyroides*).

H.R.H. (Giru)—

The specimen is *Phaseolus lathyroides*, a native of tropical America, now a common naturalised weed in Queensland. Although fairly abundant, we have not heard a common name applied to it. It was introduced many years ago as a fodder, but on the whole our experience has been that stock do not take readily to it, at least when other feed is available, although on occasions we have had specimens with the report that stock were eating it freely enough. Although introduced so long ago it is only during the last two or three years that the plant seems to have spread very much outside south-eastern Queensland, and now it seems to be throughout the coastal belt. It is a common tropical plant, widely spread over the tropical and sub-tropical countries of the world, and is not known to be poisonous or harmful in any way. We think if plant poisoning is your trouble the cause must be looked for elsewhere.

Pigweed.

INQUIRER (Townsville)—

The plant is *Portulaca filifolia*, a species of Pigweed, a native of North Queensland and the Northern Territory. The plant seems particularly prevalent this year, as we have had several specimens forwarded for identification from the North-west and Central-west. Like other members of the Pigweed family, it is not known to possess any harmful or poisonous properties, but if eaten by stock in any quantity on an empty stomach would cause "hoven" or "bloat."

"Cape Cotton."

T.M. (Dayboro')—

It is rather difficult to correctly name plants from descriptions only The usual practice is to forward small pieces a few inches long bearing either flowers or seed, and when more than one specimen is sent each should be labelled and duplicates retained, when names corresponding to numbers will be returned. However, the particular weed you describe seems to be the so-called Cape Cotton, Balloon Cotton or Milky Cotton (*Gomphrena fruiticosus*), a native of South Africa, now common as a weed in secondary growth in much of coastal Queensland. It belongs to a dangerous family of plants, the *Asclepiadeæ*, and is probably poisonous, although so far as we have observed stock generally avoid it. The plant is sometimes grown in gardens as a curiosity on account of its balloon-like pods, but on many scrub farms it becomes a terrible curse, the seeds being widely spread by the wind. When cut the plant exudes a milky sap. The bark is very tough and possesses a rather useful fibre.

Guinea Grass.

W.H., (Pine Mountain)—

The specimen is the Guinea Grass (*Panicum maximum*), quite a valuable fodder grass, either for cutting or grazing off. It has been established in Queensland for a great many years, and judging from the number of specimens received during the last few months seems again to be coming into favour. We should say a grass such as Guinea Grass, Blue Panic, &c., would be valuable in small paddocks of, say, 2 to 5 acres for occasionally feeding down. Although it produces large seed heads, a big proportion of the seed is generally infertile, and propagation is probably best by division of the roots. This has probably affected the plant's popularity. It is not known to possess any poisonous or harmful properties at any stage of its growth.

Trees and Climbers Suitable for Longreach District.

A.McG. (Longreach)—

The trees worth while trying out at Longreach are—Currajong, Citron-scented Gum, Portuguese Elm (*Celtis sinensis*), Acacia (*Albizzia Lebbeck*), Parkinsonia Tree, Pepper Tree. Algaroba Bean, *Acacia arabica*, and Bottle Tree. Some of the Pines, such as the Native White Cypress (*Callitris glauca*), *Cupressus torulosa*, and the Chir Pine (*Pinus longifolia*), might be worth trying. Palms would be rather difficult to grow; the two you are most likely to succeed with would be the Cotton Palm and the Wine Palm (*Cocos Yatay*). Of climbers the following might suit:—Common Honey Suckle, Wistaria, Minettia, the Potato Vine (*Solanum Wenlandi*), Snail Flower (*Phaseolus caracolla*), and, if your frosts are not too severe, Bougainvilleas of different varieties.

In regard to vines that can be used both for ornament and for vegetables or fruits, the ordinary Passion Vine might grow if your frosts are not too severe. We do not remember having seen the Banana-fruited Passion (*Tacsonia mollissima*) in the West. It does not fruit well on the coast in Queensland, but your cold winters might aid in this respect. It fruits quite well in the neighbourhood of Sydney. Of climbing vegetables, two beans you could use are the so-called Poor Man's Bean or Hyacinth Bean (*Dolichos lablab*), or any of the climbing varieties of the Madagascar or Lima Beans. These would probably be best treated as annuals, although the Dolichos would last more than one year, provided your frosts are not too severe. The Botanic Gardens, Rockhampton, supplies plants, and some of the ornamental trees mentioned you could probably obtain from the Curator there, Mr. H. G. Simmons.

Wheat Grass.

A.E.H. (Mooloolah)—

The common Australian Wheat Grass is *Agropyrum scabrum*. It is very common in Queensland on parts of the Darling Downs. It is occasionally seen on the coast, but just as an occasional stranger. The grass varies very considerably in fodder value. The finer strains of it are found in the cooler parts of the State, and it is quite a good grass for the Granite Belt and parts of the Darling Downs, but in the warmer parts of the State it tends to become harsh and rather unpalatable. From our observations of the grass we should say it is primarily a sheep and cattle grass rather than one for the dairying districts.

Cockspur Thistle ("Saucy Jack"). Pimpernel. An Excellent Green Manure (*Phaseolus semierectus*).

D.O.A. (Atherton)—

(1) The taller growing plant with hairy leaves and stems bore only very young seed heads, but we should say it is *Centaurea melitensis*, the Cockspur Thistle, a very bad weed in the Southern States, where it is frequently known under the name of Saucy Jack. It is less common in Queensland, although it is often seen as a weed on farms on the Darling Downs.

(2) The other more succulent plant with green leaves bore neither flowers nor seed pods, but is evidently the Pimpernel (*Anagallis arvensis*), a very common weed on farm lands in the Southern States and in Southern Queensland. It is poisonous to stock, though only on rare occasions does it seem to be eaten by them.

Regarding *Phaseolus semierectus*, this plant is quite harmless. As a matter of fact, it was introduced as a fodder, though as far as we have observed stock do not take to very readily. We have had a lot of specimens in this year, and in some cases stock certainly do seem to be eating it, perhaps because other feed was not available. It is a native of Tropical America, but is now a naturalised weed in most warm countries. It is not known to possess any poisonous or harmful properties, and makes excellent green manure.

Mitchell and Flinders Grasses.

J.C. (Ilfracombe)—

In Dr. Hirschfeld's experiments, at least two sorts of Flinders Grasses and four sorts of Mitchell Grasses were experimented with. The seeds were sown in October, and, due to good late spring and early summer rains, there was a high percentage of germination, and the plants were in full growth in January. After the seed had been gathered from the Flinders Grasses stock were turned in late in April. The Flinders Grass had dried by this time, and what was left after seed had fallen proved very palatable to cattle, these grasses being sought first. Seed was not stripped from the Mitchell Grasses, and of the four varieties stock showed most preference for the Curly Mitchell, which is the commonest in Queensland. After that the Upright Mitchell, Hoop or Wire Mitchell, and Bull Mitchell were eaten in much the order given. It is often claimed by practical stockowners in the West that failure of Mitchell Grasses to germinate has been due to the absence of January rains, but in Dr. Hirschfeld's experiments the seeds definitely germinated with early summer or late spring rains. Our limited experiments at Lawnton and the Botanic Gardens have shown negative results. It is the opinion of stockowners that Mitchell Grass must be at least two years' old before stock are put on to it, otherwise they tear it up by the roots, but these conditions probably apply only to rather loose soil. Where the soil is heavy it would, we think, be quite safe to put stock on to Mitchell Grass within the first twelve months or even less. The trustees of the Walter and Eliza Hall Fellowship of Economic Biology of the Queensland University have recently appointed a Fellow for a term of three years to investigate the question of these native grasses. He is Mr. S. T. Blake, a graduate of the Queensland University, and it might be as well for you to get in touch with him. His address is care of the Biological Department, University of Queensland, Brisbane.

Broad-leaved Carpet Grass.

J.H.O. (Burrum)—

The specimen is the Broad-leaved Carpet Grass (*Paspalum platycaule*), a common tropical grass very abundant in North Queensland. It has been established in the more southern parts of the State for some years, and is now very much on the increase. It is quite a useful grass for second class country, and on the whole we think much superior to the narrow-leaved variety that is causing some concern on the North Coast line as invading Paspalum pastures. This narrow-leaved variety of Carpet Grass is generally known as *Paspalum compressum* or *Axonopus compressus*, and is sometimes called Mat Grass. As far as we have observed in Southern Queensland, the Broad-leaved Carpet Grass (the form you send) prefers somewhat sandy land near the coast, and we do not think it is a potential danger to the better class Paspalum pastures.

General Notes.

Honoured by the King—Sir Geoffrey Evans, Former Director of Cotton Culture.

From the annual report of the Imperial College of Tropical Agriculture, now to hand, we learn that His Majesty the King, who is Patron of the College, has conferred on Mr. Geoffrey Evans the honour of Knight Bachelor. This is regarded as a well-merited recognition of his services to tropical agriculture.

Sir Geoffrey Evans is well known in Queensland, where he was some years Director of Cotton Culture in the Department of Agriculture and Stock, and where he has many friends to whom the news of the high distinction he has received from the King is especially pleasing.

In 1923 he was seconded by the Empire Cotton Growing Corporation as Cotton Adviser to the Queensland Government, and was later appointed Director of Cotton Culture while still retaining his association with the Corporation. His wide experience and organising ability were of great assistance to the cotton industry in this State during its early stages of development. In 1926 he was recalled to England and appointed Acting Principal of the Imperial College of Tropical Agriculture at Trinidad. In the following year he was appointed Principal, a post he has filled with marked ability and tact for seven years. Judging by the report, which covers a very wide field of instructional and research work, it is becoming increasingly evident that the efforts of the College to further the advancement of agriculture on scientific lines are recognised as of great value, and is widely appreciated.

Sir Geoffrey Evans served with distinction during the war, attaining the rank of Colonel with the decoration of C.I.E. Hearty congratulations are extended to him on the further recognition of his work and worth in the field of tropical agriculture.

Services of the Public Curator.

The following information is supplied by the Office of the Public Curator:—

The Office of the Public Curator has been specially created so that the people of Queensland will always have available a continuous service in all trustee and agency work, and thus avoid the many dislocations often evident in individual appointments. The service also provides for the preparation of taxation returns for clients.

The intricacies of modern tax legislation are not too readily understood by the bulk of the people, and the need is felt for advice from men who are fully conversant with all the requirements of the taxation authorities. No one is expected to pay more tax than is required, but often, because of lack of knowledge, taxpayers return as income moneys which should not be classed as such. The expert can advise you on all these and many other points, and help you in many ways to avoid bearing more than your equitable burden from taxation.

You are well advised to consider what help you need with your returns, which you are now required to lodge. The service includes, too, the receipt and checking of your assessment, and refers to all taxation returns, including land and income tax.

Another service to-day notified is that the Public Curator has always ample trust funds available for advancing on approved freehold security. You should call or write for further information direct to the Public Curator, Edward street, Brisbane, or to the Branches at Rockhampton, Townsville, and Cairns, or to any Clerk of Petty Sessions in the State. These latter are all agents for the Public Curator.

Order to Dip Stock.

Executive approval was given to the amendment of Regulations under the Diseases in Stock Acts dealing with the order of an inspector to dip infected stock. Actually, the amendments involve slight changes in the form of order to dip which the inspector issues to an owner of infected stock. The general procedure for the dipping and treatment of infected stock remains the same as that at present in force.

Staff Changes and Appointments.

Mr. H. J. D. McBean, Inspector of Stock, Milmerran, and J. T. Smallhorn, Inspector of Stock, Miles, have been appointed also Inspectors under the Dairy Produce Acts.

Mr. F. C. Coleman, Inspector of Dairies, has been appointed also an Inspector of Stock. Mr. Coleman is stationed at Pittsworth.

Acting Sergeant R. F. Dawson, Sarina, has been appointed also an Inspector of Slaughterhouses.

Mr. T. Ellis, loader for the Committee of Direction of Fruit Marketing at Eudlo, has been appointed also an Inspector under the Diseases in Plants Acts.

Mr. D. C. B. Nunn (Boonah) has been appointed an Honorary Ranger under the Animals and Birds Acts and the Native Plants Protection Act.

Mr. A. M. Taylor, Clerk of Petty Sessions, Ayr, has been appointed an Agent of the Central Sugar Cane Prices Board for the purpose of making enquiries in pursuance of the provisions of the Regulation of Sugar Cane Prices Acts in regard to sales and leases of assigned lands, and the appointment of Mr. T. R. Kennedy, Bowen, as an Agent of the Board has been rescinded.

Constable J. W. Wilson (Turn-off Lagoons) has been appointed also an Inspector under the Slaughtering Act.

Mr. E. H. Harding (Palmwoods) has been appointed an Honorary Ranger under the Native Plants Protection Act.

Mr. A. F. Moodie, Inspector of Stock, Julia Creek, has been transferred to Hughenden, and Mr. C. E. Ellis, Inspector of Stock, who has been stationed at Hughenden, will be attached to the Killarney district.

Mr. S. E. Stephens, Instructor in Fruit Culture, at Cairns, has been appointed also an Inspector under the Apiaries Act and the Diseases in Stock Acts.

Constable A. McElrea, of Mourilyan, has been appointed also an Inspector under the Slaughtering Act.

Mr. L. G. Miles, B.Sc.Agr. (Q'ld.), who has been abroad for the past three years studying plant genetics, has been appointed Plant Breeder, Department of Agriculture and Stock.

Mr. R. Mahoney has been appointed Assistant Cane Tester at the Marian mill for the forthcoming sugar season, as from 18th July, 1934.

Messrs. C. H. Jorgensen and L. G. F. Helbach, whose appointments as Cane Testers at the Mourilyan and Isis mills, respectively, were recently approved, have now been appointed to the Isis and Mourilyan mills.

Constable J. E. Carroll (Stonehenge) has been appointed also an Inspector under the Brands Acts.

Mr. E. R. Ashburn, Instructor in Agriculture, Bowen, has been appointed also an Inspector under the Diseases in Plants Acts.

Messrs. N. C. Copeman and H. A. McDonald, Inspectors of Stock at Wandoan and Jandowae, respectively, and Mr. J. R. Canty, Inspector of Slaughter-houses at Innisfail, have been appointed also Inspectors of Dairies.

Grade Standards for Banana Plants.

Regulations have been issued under the Diseases in Plants Acts prescribing grade standards for banana plants, and no person shall sell or offer for sale any banana suckers or bits unless they comply with the standards prescribed. The standards are:—

Suckers.—A sucker is an offshoot from the corm of a mature plant from a planting not less than twelve months old, provided that the corm of such sucker shall be not less than three inches in any diameter below the point of commencement of development of the pseudostem.

Bits.—A bit is a portion of a mature corm of a banana plant, previded that such bit shall consist of a well-developed, undamaged "eye" protruding not less than ½ inch above the surface of the corm to which it is attached, the eye to be not less than 1½ inches from any edge, width of surface to be at least 4 inches, and depth behind eye at least 3 inches.

Suckers and bits intended for sale shall be removed by the vendor from his plantation on the same day as they are trimmed at least half a mile from any banana plantation, provided that an agent of the Banana Industry Protection Board may authorise their removal to a place which he considers safe from beetle-borer infestation.

Queensland Royal National Show.

The Queensland Royal National Show, to be held 6th to 11th August, is acclaimed by all sections of the community as the most important agricultural event of the year. Queensland's winter sunshine is attracting thousands of inter-State visitors to the Royal Show each year. This year's ring programme will extend over eleven sessions—six days and five nights—and will include one of the most comprehensive series of hunting, jumping, and trotting events so far presented in Brisbane.

In the Women's Section of the Show, which comprises Women's Industries in all branches—Arts and Crafts, Photography, Cookery, Home Preserves, &c.—entries are exceptionally heavy, thus ensuring a fine display. Queensland women are among the most resourceful in the world, and the work displayed in this section should attract great public interest.

The Royal National Show is first and foremost educational, and this phase is exemplified in the Farm Boys' Camp. Each year 15 boys are selected from the Project Clubs throughout Queensland; a party of 10 boys has been similarly selected in New South Wales for the Brisbane Show. This year the movement is to be further extended by the establishment of a Girls' Section. As a commencement, 10 girls will be selected as guests of the Association, and a similar syllabus to that of the boys will be prepared for their education and entertainment throughout Show Week. Each section of the camp will be under the control of responsible officials right from the time of their arrival in Brisbane to their entrainment for the homeward journey after the Show. The Boys' Section will be quartered in the Valley State School; while the contingent of girls will be accommodated at the Y.W.C.A.

The Wool Exhibit which was so successful last year is to be again staged, and will be considerably enlarged. It is anticipated that several hundred sheep will be housed on the showgrounds and frequent sheep-shearing demonstrations will be given throughout show week. It is surprising how few people have actually seen sheep being shorn, and these demonstrations afford a convenient opportunity for witnessing an important feature of this truly Australian industry. It is, perhaps, on the manufacturing side that the wool exhibition is most impressive, and the forthcoming displays will reflect remarkable progress in the production of beautiful and artistic articles of personal apparel fabricated from wool.

Brisbane Catchment Area a Bird Sanctuary.

An Order in Council has been issued under the Animals and Birds Acts declaring No. 5 Division, Shire of Moreton, the Brisbane Water Catchment Area, Mount Coot-tha Reserve, and adjoining lands as a sanctuary for the protection of native animals and birds.

The Brisbane Water Catchment Area, the Mount Coot-tha Reserve and adjoining lands were declared a sanctuary a few years ago. However, requests have lately been received for the declaration of sanctuaries in various parts of the No. 5 Division of the Moreton Shire, and as about one-third of this Division is already included in the abovementioned sanctuary, a new Order in Council to cover the No. 5 Division and lands previously declared a sanctuary has been issued.

Messrs. C. Christie, R. Worley, K. Williams, and C. Mason, of the Ipswich district, have been appointed Honorary Rangers under the Animals and Birds Acts. The property used by these Scouts for a training ground is situated within the boundaries of the abovementioned sanctuary.

Instructional Course for Dairy Farmers and Pig Raisers at Gatton.

Professor J. K. Murray, Principal of the Queensland Agricultural High School and College, Gatton, advises that a short course of instruction for dairy and pig farmers will be held from 13th August to 23rd August, 1934. The course will cover lectures and demonstrations, also visits to the Brisbane Abattoirs and bacon factories. The fees will total £3 10s., covering tuition, board, and visits to factories. Further particulars and rail concession forms on application to the Principal of the College at Gatton.

Cheese Board.

An Order in Council has been issued under the Primary Producers' Organisation and Marketing Acts giving notice of intention to extend the operations of the Cheese Board for the period from 1st August, 1934, to 7th February, 1935. Provision is made for the lodgment of a petition on or before the 16th July, to be signed by not less than 10 per cent. of cheese manufacturers and suppliers of milk to cheese factories, requesting that a poll be held on the question of the continuance or otherwise of the board.

Oversea Shipment of Poultry—Customs Department Requirements.

Following are the conditions of the Customs Department for acceptance of consignments overseas. These conditions are intended as a guide for shippers, and unless they are reasonably complied with the Customs Department may refuse to pass the birds for shipment—

For the crating of fowls, ducks, geese, and turkeys for shipment overseas, it is desirable that the coops be constructed of wood, and the front be covered either with wire-netting or slatted battens, the latter preferred. The top should be sloping and the boards lapped to shed any water. Where the birds have to travel through the tropics, ample ventilation should be provided by leaving an aperature of about 2 inches along the back near the top of the coop, or by holes 1 inch in diameter bored in the back and ends near the top.

Water vessels should be provided, preferably of a type which will hang on to the front of the coop with a metal strap.

The minimum sizes desirable for the various classes of birds mentioned being despatched on a journey of seven days or over are as under, but reasonable latitude may be allowed if the journey is under seven days, as to New Zealand and Lord Howe Island.

Fowls.—For single birds the coop should have a floor space of 3 square feet (2 feet × 1 foot 6 inches) and a height of 2 feet at the back and 2 feet 3 inches in the front. Where more than one bird is being sent, not less than 2 square feet of floor space per bird should be allowed, and not more than one male bird should be put in one compartment.

Ducks.—Coops should be constructed the same as for fowls, except that the height need not be more than 2 feet at the front. An allowance of 3 square feet of floor space (2 feet × 1 foot 6 inches) should be made for single birds or 2 square feet each where more than one bird is in the compartment.

Geese.—Coops should be of the same construction as for fowls except that the height should be 2 feet 3 inches at the back and 2 feet 6 inches in front. Five square feet of floor space should be allowed for single birds (2 feet 6 inches × 2 feet) or 3 square feet each where more than one bird is in the same compartment.

Turkeys (Gobblers).—Coops should be built in the same manner as for fowls, except that the height should be 2 feet 6 inches at the back and 2 feet 9 inches in front. About 9½ square feet of floor space (3 feet 9 inches × 2 feet 6 inches) should be provided for a single gobbler or 6 square feet each where more than one gobbler is in the same compartment, but preferably gobblers should be in separate compartments, in which case 9½ square feet should be allowed.

Turkey Hens.—For single hens the floor space should be 6 square feet (3 feet × 2 feet) or 4 square feet per bird where more than one is in the same compartment, and the height may be 3 inches less at front and back.

Quarantine Area on the Near North Coast.

A Proclamation has been issued, under the Diseases in Plants Acts, declaring the parish of Mooloolah and portions of the parishes of Bribie and Maroochy to be a quarantine area for the purposes of the Acts. This Proclamation also rescinds a Proclamation issued on the 27th February, 1930, which prescribed the existing boundaries of the quarantine area to be between the Maroochy River and the main Caloundra-Landsborough road.

This action has been considered desirable in view of the progress of bunchy-top infestation northward of the boundaries of the present area, and, in addition to taking in the areas where bunchy top has recently made its appearance, it will also provide what is looked upon as a safe margin.

Butter Board.

An Order in Council has been issued under the Primary Producers' Organisation and Marketing Acts extending the operations of the Butter Board for the period from 1st July, 1934, to 7th February, 1935. The Order further provides that the present members of the Board—namely, J. Purcell (Toowoomba) (chairman), W. J. Sloan (Malanda), R. M. Hill (Bororen), J. McRobert (Maryborough), T. F. Plunkett (Beaudesert), A. G. Muller (Fassifern Valley, Kalbar), and E. Graham (Director of Marketing), whose period of office terminates on the 30th June, shall continue in office until 7th February next.

Purchasing Store Pigs.

A word of advice to those who intend purchasing or who regularly make a practice of buying store pigs will not be out of place, seeing that a number of instances have been recorded recently in which bad results have followed the purchases and money has been lost on the transaction. Inexperienced persons who set out to purchase pigs for finishing for market should endeavour, wherever possible, to secure pigs not less than fourteen or sixteen weeks old.

It is disastrous buying pigs six weeks old and expecting them to make progress or to prove satisfactory, especially as these very young unweaned pigs often cost more at auction than those carrying more age. There is an old saying, "Never buy a pig in a poke," which literally means never buy a pig of whose breeding or development you know nothing. Fortunately, under the conditions on which pigs are offered for sale at public auction in this State, the buyers' name and postal address must be announced before the pigs are offered for sale, but though this is a valuable safeguard against the spread of disease it is not everything, and buyers should certainly know something of the conditions under which the pigs intended to be purchased have been developed, the foods used in their production, whether they come from a farm free of disease, the breeding, age, and any other information available. The purchase of pigs from breeders with a well-known good reputation is usually a safe proposition, and it would be preferable to purchase only from well-known breeders if we are to succeed in our efforts to eradicate and/or trace disease to its source of origin. Lice, worms, and other parasites that infect the pigs are readily conveyed from one to another.

When selecting pigs from a litter, for delivery after weaning at correct age, secure the strongest and best. They will repay the extra cost of two or three shillings per head and prove to be good buying. The same may be said of purchasing stock already weaned and making good progress. Never buy pigs manifestly diseased or with abscess formation, ruptures, piles, or open and suppurating wounds. It is wise to have the stock or dairy inspector have a look at the pigs you intend purchasing in order to have an additional safeguard. It is best to avoid purchasing pigs which are in poor, emaciated condition or are stunted in growth and which give evidence of unthriftiness. Avoid purchasing where the pigs are crowded together in a small and possibly a badly lighted pen, for some sellers are so unscrupulous that they will pack a few ruptured or unhealthy pigs in among a lot of better-class stock in order to reap a benefit of the few extra shillings which better pigs would, in any case, realise.

If there is the slightest doubt about the transaction throw the responsibility on the auctioneer or the vendor and have them explain why certain diseased pigs were sold by them. These are all matters of commercial interest to farmers, especially those who wholly or partly depend on the purchase of store pigs for finishing. Store pigs are those between approximately two and a-half and four months of age, midway between weaner and "slip" stage and light porkers (four to four and a-half months).—E. J. SHELTON, Senior Instructor in Pig Raising.

State Schools' Eisteddfod.

The Queensland State Schools' Eisteddfod will be held at the City Hall, Brisbane, from 13th August to 18th August. The purpose of the Eisteddfod is to demonstrate the high standard of musical performance attainable in Queensland schools, and to allow teachers and pupils the benefits of comparison and criticism by an eminent musical adjudicator.

Special railway fares have been arranged for country competitors. For children a special rate at one-quarter the regular adult excursion fare will be charged. Conductors and pianists will be charged one-half the adult excursion fare. Parents and other grown-ups travelling to the Eisteddfod will be charged at the special rates prevailing for Exhibition Week.

Visiting choirs will be billeted with children attending Brisbane schools, on the basis of one or two visitors to each home, so that children from country schools who are members of a school choir will be saved the expense of accommodation.

It is intended to make the Eisteddfod programme a very attractive one, and the whole week should be enjoyable to those who make the journey. Furthermore, the reduced fares (both for children and adults) should make the time a favourable one for a holiday visit to Brisbane.

The farmers' support of the venture should do much to ensure its success.

Trees on the Farm.

The advantages of windbreaks on a farm are:—

Firstly, they break the mechanical force of the wind, thus preventing undue damage to orchards by breaking off limbs, blossoms, and fruits. The production of blossoms, fertilization, and maturing of fruits cannot be satisfactorily carried out in places open to the full force of high and frequent winds. Further, the lodging and damage by wind of other farm crops, such as maize, &c., can be prevented largely by suitable shelter belts.

Secondly, they provide a very necessary shelter for stock of all descriptions. To see a mob of cows or sheep huddled beneath a tree during the bitter winds of winter is to realise that the health and well-being of stock demand the provision of some efficient shelter. Too much food material is wasted in "warming the wind," or in meeting the increased demands of an exposed body. Sheltered animals require less food. Stock-owners agree that mortality among sheep, particularly during lambing and shearing seasons, would be considerably lessened if good shelter were available. Animals clearly demonstrate their need for shelter, and if the stock-owner were to provide it he would add considerably to his profit.

Thirdly, windbreaks prevent soil erosion and removal of topsoil due to unrestricted wind action. This is particularly in evidence where light soil predominates and little natural cover exists. The effects of dust storms are mitigated.

Fourthly, they reduce evaporation and help to conserve the soil moisture. Where the wind is unrestricted, evaporation goes on at a rapid rate. In the immediate lee of a windbreak evaporation is reduced by as much as 60 per cent., and actually at one point it has been shown, under ideal conditions, to reduce evaporation by 70 per cent. The protective zone of a break varies with local conditions, but, generally speaking, it shelters an area equal in width to six to fifteen times the height of the trees. A narrow strip is also protected on the windward side. In the protected zone the average reduction in evaporation falls round about 30 per cent., the moisture retained in the soil being available for crop needs.

The actual result of a breakwind in reducing evaporation is therefore equivalent to a fairly large increase in rainfall. Areas unsuited for certain crops by reason of an insufficient rainfall might, therefore, be made to grow them profitably if protected by efficient breaks.

Fifthly, when planted near dwellings, they add greatly to the personal comfort of the farmer by protecting the home buildings from the extremes of winter cold and summer heat, and from dust storms. The home is made an infinitely more pleasant place to live in if the owner will go to the small amount of trouble entailed in planting a belt of trees.

Lastly, when planted on a big scale they can be made a source of timber and fuel supply for farm needs, and even assume the character of a tree plantation.

The claims of the windbreak can hardly be ignored by the orchardist, farmer, or pastoralist.

Farming's Inevitable Gluts.

The history of agricultural effort the world over has been an inevitable series of booms and serious depressions. Is it possible to "iron out" these high and low peaks? Some of the best brains of the world have applied themselves to the problem, and they turn to international control as a remedy. Yet the brilliant young English economist, H. V. Hodson, whose book, "Economics in a Changing World," is already almost a classic, speaks thus of the quota and other restrictive remedies: "As a nostrum for the world's economic ills they rest on the profound fallacy that the paradox of poverty in the midst of abundance has its sole solution in perpetuating poverty by abolishing the abundance."

Yet the same clear thinker has to admit that primary production does tend to increase faster than the effective demand, and that this lends an element of instability to the whole business system. "The reason is," he says, "that primary production increases in efficiency with the aid of mechanical and chemical science, at least as rapidly as the total wealth of the world. On the other hand, as real income increases, a diminishing proportion of it is devoted to primary products, and a rising proportion to the higher stages of manufacture, and to services of all kinds. Thus, until the least efficient producers are squeezed out, primary prices have a perpetual tendency to fall, periodically, to quite unremunerative levels."

These extracts, only a trifling proportion of the quantity of informative and thought-provoking material which has come under the writer's notice, are reproduced to show how the problem is vaster than is possible of final and complete handling by any board representing the producers of an industry. Governments have taken a hand in trade policy all over the world, and only Governments can deal with Governments.—"The New Zealand Farmer."

Bacteria in Milk and Cream—Sources of Contamination.

Bacteria thrive in milk, and every precaution must be taken to prevent their entry. This susceptibility, and the fact that bacteria are everywhere, makes the production of a sterile milk by the farmer impossible, but knowledge and avoidance of the chief causes of contamination should enable him to market a very satisfactory product, writes an officer of the Biological Branch of the New South Wales Department of Agriculture.

The Cow.—Milk is contaminated before it leaves the healthy cow. There are always some bacteria living in the milk ducts, &c., but luckily these forms are rarely numerous and seldom cause a noticeable change in milk, even after standing for many days. However, should the udder be in a diseased condition the milk may be abnormal before it leaves the cow. Ropy or curdled milk is often drawn under these circumstances.

Materials adhering to the outside of the teats and udder frequently bring about important contamination. When the cows rest at night time this portion of their body comes into direct contact with the ground and becomes smeared with droppings, &c., which contain extremely high numbers of bacteria. From here they readily gain entry to the milk. A similar process brings about contamination from the tail, which is always in an insanitary condition. Particularly during the spring and summer months, the fly pest causes the tail to be in constant motion, and unless more than ordinary care is observed, the tail will find entry to the bucket during hand-milking.

Contamination from the Air.—Varying amounts of contamination take place from the air in and around the milking bails. Some yards are dusty, and unless the cows are all in a contented mood, a certain amount of milling takes place and results in flying dust. Such dust has invariably been fouled and adds large numbers of bacteria to the milk. Again, the practice of feeding hay or silage to the cows while they are being milked is sometimes followed. Yeasts, moulds, and bacteria gain entrance to the milk from this source.

The Careless Milker.—In some instances carelessness on the part of the milker results in contamination. Unwashed hands are always insanitary, while hands which may have been thoroughly clean at the outset soon become dirty, as a result of contact with the animal. Some people have the habit of "wet" milking, and this is much more insanitary than the "dry" method.

Water as a Source of Contamination.—On several occasions faults in milk and cream have been traced to stagnant water. While the popular belief that the drinking of such water is, in itself, the cause of subsequent deterioration is unfounded, the fact remains that bacteria from such water often gain indirect entry to the milk. Mostly the cattle wade in a polluted swamp searching for watercress, or they may even have to cross a stagnant creek in being driven to the milking yard. The body, including the teats and udder, is fouled in this manner and the bacteria are later added to the milk while it is being drawn.

The biological quality of the water used for washing down the udder is also of importance. When cow after cow is washed with the same cloth and water from the same pail the water becomes more and more insanitary and a source of pollution to the milk. Sometimes the water is unsuitable at the outset, being taken from iron tanks in which manurial dust, blown from the yard to the roof and washed down the spouting, has been allowed to accumulate for months.

Unsuitable and Dirty Utensils.—By far the greatest number of bacteria are derived from the utensils. Kerosene or petrol tins have a groove at the bottom from which it is impossible to remove all traces of milk. This material supports the development of large numbers of bacteria which attack the fresh milk immediately it is poured into the can.

Concerning the value of a milking machine on the farm, there are two very definite opinions, and one of the strongest arguments used by those who condemn the machine is the irregular quality of the milk drawn through it. Naturally there are many places in which bacteria may become lodged in the mechanism. In earlier patents, communication of condensed water or trapped milk from the air line to the milk line frequently occurred, and even with recent models if the units are not conscientiously dismantled and cleansed, serious contamination of the milk soon results.

Next to the milking machine the separator may be classed as the most likely source of contamination. The discs are the chief trouble. Much casein and other slime becomes settled between the individual discs during the skimming process. The removal of this material necessitates extreme thoroughness of washing, with the result that some of it is frequently left behind and breeds up an undesirable

inoculum for the next separation. Even when carefully washed the discs are often left so close together that they fail to dry, and in the droplets of water between them bacteria, and often rust spots, develop.

Cloths.—In many dairies cloths find favour as an aid in the washing up process; and in many dairies cloths are a source of contamination which results in the rapid deterioration of the quality of milk and cream. Cloths retain the fat, casein, &c., and unless carefully spread out take a long while to dry. Under such conditions they rapidly become foul-smelling and are a source from which countless micro-organisms gain entry to the milk. If kept sanitary by careful washing, rinsing, boiling, and quick drying, a cloth is probably less dangerous than a brush, for in the latter it is practically impossible to free the base of the bristles from greasy materials.

Facts about Animals.

The Creator gave various animals special prehensile organs and attributes to enable them to exist in the same environment. Observation makes some of these special features apparent and it would be well for every young farmer to note them in the animals he has to feed.

Many of them, however, have not been noticed by the average stockmen, and are worth mentioning. For instance, the sheep has a cleft upper lip, that it may spread the sections apart and get its teeth close to the ground for short herbage cropping.

The cow takes its forage in a different fashion. Her tongue is rough like a rasp, and with it she gathers between her eight incisor teeth of the lower jaw and the cartilaginous pad of her upper incisors, locks or tufts of grass which she then wrenches and cuts off for mastication with her molar or grinding teeth. In a time of drought, when grass is dry and loose in the ground, the roots, with some soil attached, commonly enter the cow's mouth with each tuft of grass; but the cow discards the soil and it falls from one side of her mouth. At such times one will find little heaps of this discarded soil everywhere on the pasture. This is not done by the pasturing horse. The rigid teeth of the upper and lower jaw seize a tuft of grass and cut it off for chewing. If soil comes with the grass it is swallowed, and so much "dirt" or sand may be thus taken in as to cause indigestion or colic, which often proves fatal.

The horse's tongue is long, slim, and smooth, instead of being rasp-like, and the ridges of the horse's hard palate are also smooth, as is the lining membrane of the cheeks. Look into the cow's mouth and you will see that some long, teat-like objects (papillæ) project from the inner surface of the cheeks, especially on a level with the grinding surface of the molar teeth, and the ridges of the palate are also rough, with saw-like edges pointing backward.

The papillæ and points of the palate ridges or "bars," together with the roughness of the tongue, are intended to help the cow retain the feed in her mouth while chewing her cud. A farmer once wrote us that when his cow was sick he looked in her mouth, saw the papillæ mentioned, thought they were warts, cut them off, and reported that the cow was not a bit better after the operation. It is well to know the facts about such anatomical features.

That is also true regarding the teeth. The incisor teeth of the cow normally or naturally are somewhat loose in their sockets, but the looseness has often been blamed to the eating of silage, by the uninformed stockman. So has the early wearing away of the cutting parts of the incisor teeth. That occurs when the cow is ageing, so that when she is twelve years old, and sometimes when she is younger, one may find little rounded stubs, like collar buttons, projecting from the gums, instead of large, broad, shovel shaped teeth. The broad parts quickly wear off and the slim necks remain. In the horse, however, the incisors, above and below, last the animal until it is twenty or more years old.

The hog "goes" the cow and horse "one better" when on pasture. It roots below the surface to obtain feed, grubs, minerals, &c., and, therefore, is fitted with a special bone in its snout and a ring of strong gristle as well, to make rooting possible; and speaking of extra bones, you will find two of them in the cow's heart, but none in that of the horse. A moment of thought will enable the reader to understand, with these facts about domestic animals, why the giraffe has such a long neck, the elephant its trunk, the ant-eater its elongated proboscis, the carnivorous or flesh-eating animals their fangs and bone-crushing molars, and the feline animals their claws, which have special muscles to keep them hidden or spring them into savage action.—"Hoard's Dairyman."

The Imperial Sentiment.

Unfortunately the strongly expressed feelings of the British farmer in regard to disastrous competition from the Dominions, and the latter's resentment of proposals for regulation, have led to a feeling of constraint, which is not going to improve Imperial relations. This factor is realised in England, and it is good to find so important a journal as the London "Times" reproducing on its leading-article page, in issues just to hand, a series of articles on the whole situation, written with special regard to the viewpoint of the overseas countries of the Empire. These are lengthy contributions, very faithfully covering all aspects, and the opening paragraph will be read by our own producers with the greatest interest:—

"What is prudence in the conduct of every private family can scarce be fault in that of a great Kingdom. If a foreign country can supply us with a commodity cheaper than we can ourselves make it, better buy it of them with some part of the produce of our own industry employed in a way in which we have some advantage. Adam Smith in 1776," continues the writer, "gave this exhortation which seems to be the veriest commonplace. Yet in December, 1933, the wholesale price of butter was 69s. per cwt. in London, 184s. in Berlin and Belgium, and 238s. per cwt. in Paris. These prices give some indication of the extent to which the commercial policy of nations has departed from the commonsense of the economists."

The agrarian policies of Continental countries is explained, some of the illuminating facts quoted being that Switzerland has, through its changed policy, reduced butter imports from 200,000 cwt. in 1931, to 10,000 cwt. last year. Although in 1928 the Continent was importing six million cwt. of beef per annum, this has been reduced to four million cwt., and the process involved increasing pressure on the only open market, Britain, and, as the writer remarks, "until the Ottawa quota began to operate, the pressure of superabundant supplies was having a disastrous effect upon the price of domestic beef."

Britain's increasing ventures into protection for its farmers is described, wheat in Britain, for instance, being twice the price of world parity, while the encouragement of the beet-growing industry results in sugar having to be produced at a quite uneconomic price, compared with that in the normal sugar-producing countries. "If the present state of affairs continues," comments the writer, "we shall be forced to contemplate the wholly unsatisfactory spectacle of the low-cost producers of Denmark, New Zealand and Canada or Australia, being forced to abandon their farms because Governments of the industrial countries are determined to make production remunerative to their own sub-marginal producers. This is a challenge to economic sanity."

The last point leads up to the question of what the British Government will regard as a "remunerative" price, and for whom? The reasonably efficient, or the inefficient farmer? The explanation of the new agrarian policy of the British Government, as given by this obviously well-informed writer, is that it is determined to use the bargaining-power of its great market for food-stuffs, to promote export trade in manufactures, combined with the desire to secure prosperity for the Home agriculturalist. It is the harmonising of these factors, with the natural desire of the Dominions to expand and develop, which is the problem of to-day.—"The New Zealand Farmer."

How to Pit Potatoes.

A level piece of land, so situated as to ensure drainage, should be selected for the pitting of potatoes for winter storage. Two poles or saplings are placed on the surface, parallel to one another and 4 feet apart, and the potatoes are emptied in between these so as to form a well-ridged heap. The potatoes are then covered with a thatch of straw or other suitable material, and this again is covered with sods of earth. It is important that the sodding should be done from the ground upwards (as in shingling a roof). When completed, the whole is beaten well down with the back of a spade, and a drain is cut round the put to run off the water in case of rain.

Potatoes for pitting should be as dry as possible. If weather permits, it is well to let a fortnight or so elapse before earthing up—that is, to leave the potatoes with only their straw covering so that sweated moisture may be carried out. For a small pit (say 1 ton) the best shape is a cone.

It should be remembered that unnecessary exposure causes a deterioration in quality. Light causes a greening of the skin, and even a partial exposure may cause a yellowing of the flesh.

Colic in Horses.

It is extremely difficult to differentiate between the various gastric and intestinal affections in the horse, and most complaints seem to be placed under the heading of colic. The name is given to a train of symptoms which horses show when they have pain in the abdomen. In the horse two forms of colic are distinguished, namely, spasmodic and flatulent—

In spasmodic colic the pain is not continuous, but there are intervals of ease between the spasms, during which the animal appears quite well, until another spasm suddenly occurs. The animal is generally violent, paws, stamps, kicks at its belly, lies or throws itself down, rolls, crouches in the loins when walking, stretches itself out, looks round at the sides, and sweats either in patches or all over. The pulse is fast, the breathing hurried and distressed, and the mucous membrane of the eye is red, but the temperature remains normal. Between spasms the animal appears quite well, and will start feeding if allowed. As the attack progresses, the pains get more frequent and longer, and the intervals free from pain shorter. Constipation is a symptom as a rule.

The animal should be walked about, and on no account permitted to lie down or roll. The following drench should be given at once:—1 drachm oil of peppermint, 2 ounces aromatic spirits of ammonia, 1 pint linseed oil. Keep well shaken, and drench slowly.

If relief is not obtained in an hour, repeat the mixture, substituting thin gruel for the linseed oil. This may be repeated till three doses have been given, at intervals of an hour. Apply hot fomentations to the abdomen for periods of half an hour at a time, keeping the temperature of the water so high that the hand cannot be kept in it—half-cold fomentations are quite useless—or mustard mixed sloppy in a basin with vinegar may be rubbed over the belly. Give copious enemas every hour. If, in spite of this treatment, the animal is still not relieved, give the following drench, repeating if necessary every three hours:—1 ounce chloral hydrate, 1 pint thin gruel.

Flatulent colic is due to fermentation of the food in the bowels, which become distended by the resultant gases. The belly is inflated, giving the animal an unnaturally round appearance, and the pain is continuous, though not so violent as in the spasmodic variety. The animal does not throw itself about so much, but appears somewhat sleepy, though uneasy and fidgety, scraping, wandering slowly round, attempting to lie down, but afraid to do so.

The following drench should be given at once:—2 ounces oil of turpentine, 2 ounces aromatic spirits of ammonia, 1½ pints linseed oil. Shake the drench very frequently whilst giving.

Walk about and give enemas and fomentations as in spasmodic colic. If the pain is not relieved in two hours, give an ounce of oil of turpentine in a pint of thin gruel, and repeat again in two hours if necessary. If still not relieved, give the chloral hydrate as in spasmodic colic. As an after treatment, when the pain has subsided, feed the animal on bran mashes for twenty-four hours. It is also best not to work the horse for two or three days.

In drenching, if the animal struggles, or attempts to cough, immediately lower the head. A portion of the drench may be wasted, but unless this is done the fluid will be likely to pass down the windpipe, and the horse die of pneumonia.—A. and P. Notes, New South Wales, Department of Agriculture.

Kikuyu Grass Sets Seed.

The first record of Kikuyu grass (*Pennisetum clandestinum* Chiov) forming seed in Australia comes from the Comboyne district, New South Wales. Writing to the New South Wales Department of Agriculture on 26th March last, Mr. Les. Pfeiffer stated that for several years past on his property this grass had formed the female portions of the flowers, but that this year a small patch was bearing complete flowers and setting seed. On 16th April he forwarded specimens of immature flowers and also mature ones carrying seed.

The Comboyne plateau is 1,900 feet above sea-level, and the average annual rainfall over a period of eight years is 63.80 inches.

Kikuyu grass was first grown in Australia from seed obtained by us from the Belgian Congo in 1919. This seed was planted at the Botanic Gardens, Sydney, and sufficient cuttings were thereby obtain to enable a plot to be planted at Hawkesbury Agricultural College, Richmond. Most of the Kikuyu grass now growing in this and other States was distributed from these two centres.

Points for Pig Raisers.

The ambition of the pig raiser should run along something of the following lines:—

More pigs per litter and more weight for age.

Better and healthier pigs and more protection from disease.

Lower mortality and better control of disease.

Better proportioned and more attractive carcasses and more profitable returns.

* * * * * *

Improve the condition and increase the stamina of your pigs by using properly balanced rations, by regularity of feeding, and by keeping the pigs under strictly sanitary conditions.

* * * * * *

The liberal use of minerals, and, where necessary, of the commoner drugs, will do much to ward off disease and enable pig raising to be carried on with a greater margin of profit. Properly compounded mineral mixtures are invaluable for developing bodily strength in the animals and in generally improving the health of breeding and young stock.

* * * * * *

What should a litter of pigs weigh at three weeks of age? A well known manufacturer of commercial pig meals in Great Britain advertises that under efficient management and with properly balanced foods a fair average would be 7.5 pigs at 10.5 lb. each, equally 78.75 lb. per litter. The firm referred to claims that by the use of their food it is quite possible to increase this average to 8.39 pigs at 12.4 lb., equally 104.8 lb. at three weeks of age. They like their customers to regularly weigh their pigs.

Deficiency Disease in Cows.

Referring in a recent report to cases of deficiency disease in dairy cows on the Central New South Wales Coast, the Chief Veterinary Surgeon of the New South Wales Department of Agriculture draws attention as follows to the value of a sterilised bonemeal lick:—

"There appears to be a tendency rather to use complicated licks for cattle suffering from phosphorus deficiency when in reality bonemeal or dicalcic phosphate is the only thing required in addition to common salt. Alternatively, of course, the necessary mineral matter may be provided to the cattle through using artificial fertilizers on the pastures, and the benefit derived would be very greatly increased were the farms more markedly subdivided. In connection with the use of steriilsed bonemeal and the value to be derived from its use, reports on investigations recently carried out in Florida are to hand. These reports stress the point that in very deficient country regular access to bonemeal is required over a prolonged period if cattle are to be expected to produce satisfactorily and to breed at the same time."

Horse Market Revival—Stallion Parades.

The Minister for Agriculture and Stock (Mr. F. W. Bulcock, M.L.A.) has expressed his satisfaction at the revival in horse sales in many country centres, as indicated in recent press reports. The Minister also referred to the Stallions Registration Acts, which have for their primary object the elimination of the unsuitable and unsound horses of all breeds, and expressed the opinion that this desirable objective could only be achieved with the co-operation of breeders and owners. Mr. Bulcock emphasised the necessity for owners complying with the legislative provisions, which insist on examination and registration of stallions.

Arrangements are now in progress for the annual examination of stallions, which will be carried out during the next two or three months at various centres appointed for that purpose, and the attention of owners is directed to parades advertised in metropolitan and district newspapers. Strict compliance with the provisions, which prescribe compulsory registration, is to be enforced in future.

At any sales held intending purchasers of stallions should insist, for their own protection, on the production of a certificate of registration of the animal under the Stallions Registration Acts, as uncertificated horses are prohibited from being used for either public or private service.

The Home and the Garden.

OUR BABIES.

Under this heading a series of short articles by the Medical and Nursing Staffs of the Queensland Baby Clinics, dealing with the care and general welfare of babies, has been planned in the hope of maintaining their health, increasing their happiness, and decreasing the number of avoidable deaths.

PLAYING WITH BABIES.

This article appeared in the newspapers of New Zealand a few years back.

A RECENT spectacle of a bright, intelligent baby being treated as a plaything by every member of the family concerned leads us to touch once again on this subject.

Play is a natural instinct which man has in common with the lower animals. It seems that the higher an animal comes in the scale of creation the more highly developed is its instinct for play. When we come to the domestic animals we see playfulness developing in proportion to the intelligence, and in the apes and monkeys playfulness is retained throughout life.

It is right and natural that baby should play—something is radically wrong if he does not early show this instinct—but

How Does He Play?

Kicking exercise is the baby's earliest play. From it he derives numerous sensations which give him pleasure. Later this leads on to the discovery of his first and best playthings—his own fingers and toes—best because in addition to their fascinating habit of unexpectedly appearing and disappearing, he derives twofold pleasure from playing with them; that of touching and of being touched. Then he comes into the realms of playthings apart from himself, though not necessarily rattles or playthings proper. Every object within his reach is a potential plaything, and life consists of one great game—the adventure of satisfying curiosity.

This sort of play is utterly satisfying to the unspoilt child, besides being satisfactory and safe. Baby can play it in his own time and at his own pace. When he is tired he can stop; if he goes on a little too long Nature steps in and he sleeps till his nervous energy is restored. His developing faculties are healthily stimulated without the slightest danger of over-stimulation of the delicate nervous system.

The Wrong Sort of Play.

How different is this from the case when the baby is *played with*. Then stimulation is applied in *our* time, at *our* pace, and the result is inevitably a certain degree of over-stimulation, unless the process is kept within strict limits.

Just watch a baby responding to prolonged playing of this kind. The eager, responsive type of child quickly reacts, and his delicious

gurgles and chuckles charm us. If a very little of this is allowed to go a very long way no harm is done, but the first signs of wandering attention or fretfulness are certain signs of fatigue and should be the signal to *stop*. Too often, unfortunately, they are taken as the signal for more strenuous efforts at so-called amusement, to which the baby again responds, though after a time there is probably a slightly hysterical note in his laughter and gleeful shouts. Presently everyone is tired, yet it may strike no one that the baby is fretful and will not sleep for the simple reason that he is nervously exhausted.

Put Yourself in the Baby's Place.

Just imagine one's feelings if a creature of ten times one's size and mental capacity (though not necessarily possessed of intelligence to match) insisted on prolonging certain diverting antics beyond one's powers of spontaneous response! It does not require much effort of the imagination to see that this sort of thing carried on over a long period may mean wrecking of the nervous system with some temperaments. *The bald fact of the matter is that adults play with babies for their own amusement, not the babies' pleasure.*

Someone has suggested that a baby affects many women much as a mechanical toy affects many men. "Give a child a clockwork engine and father won't be able to leave it alone. Give him also a few trucks, a toy railway signal, and 6 feet of tin track and he will neglect his business!" So with many a woman—give her a baby and she can't leave it alone. All unknowingly she satisfies her own play instinct at the expense of the child.

Mothering.

One does not mean to imply for a moment that the baby should receive no attention. Babies allowed to grow up without a certain amount of handling and loving attention become pale, flabby, and listless.

What one does mean is that the greatest part of the direct stimulation should come to the child in the simplest way along with tender and skilful "mothering" and "handling," at feeding and bathing times chiefly. The sum of exercise and stimulation obtained in this way during the course of the day is very considerable and quite sufficient for the young or easily stimulated baby.

A judicious amount of more direct "playing with" may be allowable, according to the type of child, so long as the caution indicated in a previous paragraph is observed. In addition, remember that there is one time when a baby needs no stimulation whatever, and that is just after a meal. Yet, by some contrariness, this is just the time when it is often given, the poor little mite being jogged and patted and talked to.

Troublesome digestive disturbance may be due to this cause, and this alone. A persistent habit of vomiting may be set up which affects progress and requires a prolonged period of treatment for cure. We have many such cases admitted to the Karitane Hospitals, some of whom need practical isolation for a time so over-stimulated are they.

To sum up, the less babies are deliberately played with the better, and there should be no playing near meal times or within an hour or so of bedtime. Injudicious playing with infants makes them nervy and cross, disturbs their sleep, disturbs their digestion, and may cause

undesirable conditions in other respects. If one must play with the baby let the play be of very short duration, stopping short of the first sign of fatigue, gentle and quiet, not boisterous, and not with a whole gallery of spectators looking on and perhaps joining in. The baby's early play should be mainly with his first playmate—himself and his own fingers and toes.

IN THE FARM KITCHEN

BREAD-MAKING.

A GOOD bread-making flour is essential: some flours make excellent cakes and puddings, but are not good for bread-making. This is because bread requires a flour containing plenty of gluten. Some varieties of wheat make a flour low in gluten content, and these are not suitable for bread.

Yeast works best at temperatures of from 77 to 95 deg. Fahr. Keep the dough near the stove in cold weather and during heat waves put in cool place or it will rise too quickly and give a loaf that is too porous. Yeast will not work below 30 deg. Fahr., and is killed at 212 deg. Fahr. Salt retards the action of the yeast slightly; it should not be added till the dough is working well.

A little sugar improves the loaf. It prevents the crust from being too hard. The water or milk used to mix the bread with should be scalded and then allowed to cool down to lukewarm—about 103 deg. Fahr. Milk makes a very nutritious loaf with white crumb and rich crust. If all milk cannot be used try half milk and half water.

Cook for one hour; start with a hot fire (400 deg.) and decrease the temperature after a while. The cooking drives off the carbon dioxide and kills the yeast plant, so that it does not rise any more.

Troubles in Bread-making.

Over kneaded dough is sticky and will not rise; under-kneaded dough is streaky and the bread will contain lumps of dough that have not been worked out.

Too much flour gives too stiff a dough, rises very slowly, and the flavour will be poor.

Too long a rising will give a porous loaf with poor flavour. If the rising continues too long, the bread will settle over the side of the tin or become sour.

Too cool an oven will make the bread rise too long and it will be too porous.

"Rope" is caused by a bacillus; it often appears in hot, damp weather. When the bread is about a day old the crumb goes stringy or ropey and the flavour is so disagreeable that it is quite unfit for use. This disease is hard to get rid of. The treatment is to sterilise all utensils, and add vinegar equal to 2 per cent. (one tablespoon vinegar to 1½ lb. flour) of the flour used, for all the remaining flour you have.

Recipes for Yeast.

Yeast is a microscopic plant, which, when given food, air, warmth, and moisture multiplies very rapidly and produces carbon dioxide; this stretches the gluten and the dough rises. There are three main kinds of yeast. Compressed yeast comes in small damp cakes; it is ready to work immediately it is given the food and moisture, &c., and will keep in good condition two or three days. Dry yeast is a mass of yeast plants dried and mixed with some kind of meal. Although alive, it is inactive, and even after it has been given the food, warmth, and moisture it takes some hours to start working well. It is sold in tins and will keep some months. Liquid yeast may be made at home as follows:—

Cream of Tartar Yeast.—Put 1 heaped tablespoon of hops in a saucepan with 4 cups water and boil twenty to thirty minutes. Put 1 tablespoon sugar, 1 teaspoon cream of tartar into a basin, strain the boiling hop water on to it and stir; when cold mix with 3 tablespoons flour and add 1 tablespoon old yeast. Put in basin, cover with plate, and keep in a warm place near the stove for twelve to eighteen hours. It is then ready for use. Stand in a cool place, and it will keep for a week or ten days in cool weather. Use three-quarters of a pint of this to make 3 to 5 lb. bread.

Potato Yeast.—Materials: Three potatoes, two pints boiling water, half cup flour, one-quarter teaspoon ginger, one tablespoon sugar, one and a-half tablespoons salt, half cup old yeast. Peel the potatoes, cut small, cook in the boiling water, mash potatoes. Mix next four ingredients and pour over them the potatoes and water in which they have been cooked. When lukewarm add old yeast. Keep lukewarm for twenty-four hours, put into basin, cover, and keep in cool place. Will keep two weeks.

Neither of these yeasts requires bottling or cooking.

TOMATO SOUP.

Materials—2 lb. tomatoes; 2 onions; 2 slices bacon; 1 tablespoonful dripping; 1 tablespoonful sago soaked in 1 cup of water; 1 teaspoonful sugar; 1 teaspoonful salt; 1 pint water; 3 pints stock; pepper.

Utensils—Bowl; knife; saucepan; basin; sieve; wooden spoon.

Method—

1. Wash sago in three waters; soak it in 1 cup of water; wash, peel, and cut up tomatoes and onions.
2. Cut up bacon into small pieces; put dripping and bacon into a saucepan; fry for 3 minutes.
3. Add cut-up vegetables, salt, and sugar; fry for 10 minutes, stirring constantly.
4. Add water; simmer for 1 hour.
5. Strain soup into a bowl, rubbing the thick part through the sieve with a wooden spoon.
6. Return the strained liquid to the saucepan; add stock and soaked sago; boil till the sago is clear; season with pepper and salt as required.

Notes—

1. Tapioca may be used instead of sago.
2. This soup may be made without stock, using 2 quarts of water instead of 1 pint water and 3 pints stock.
3. It may be made with milk, using 3 pints water and 1 pint milk; in this case ¼ teaspoonful of carbonate of soda and the milk are added about 10 minutes before the soup is served.
4. The bacon may be omitted.

FRUIT PIE.

Materials—For pastry: 6 oz. flour; 3 oz. dripping; ½ teaspoonful baking-powder; ½ gill water; salt; 1 dessertspoonful milk for brushing over; 1 teaspoonful sugar for sprinkling over the finished pie. For filling: 1 lb. fruit; water and sugar as required.

Utensils—Pie dish; knife; basin; bowl; pastry board; rolling-pin; teaspoon; fork; brush.

Method—

1. Fill a pie dish with prepared fruit, piling the fruit high in the middle, and adding sufficient water or juice to come to about 1 inch below the inner edge of the dish.
2. Sift flour, baking-powder, and salt into a bowl.
3. Rub dripping into the flour with the tips of the fingers; mix into a dough, adding the water slowly.
4. Turn out on a floured board; knead lightly.
5. Roll out to the thickness of ¼ inch; cut a strip about 1 inch wide, and long enough to cover the edge of the dish; wet the edge, put the strip of pastry on it; wet the upper surface of the pastry.
6. Cover the fruit and the strip of pastry with the remainder of the pastry; cut round the outside edge, working the knife downwards.
7. Ornament the edge with a spoon or fork; decorate with leaves cut out of scraps of pastry.
8. Brush over with milk or water; sprinkle with sugar.
9. Bake in a moderate oven until the pastry is a golden brown colour; this will take at least 30 minutes.

To prepare the fruit—

1. Apples, pears, quinces, and other large firm fruit must be peeled, cored, quartered, and stewed with sugar before they are put into the pie dish.

2. Berries and small fruit should be wiped; they should not be washed. Sugar must be added, the quantity depending on the kind and ripeness of the fruit.
3. Dried fruit should be washed and soaked for 12 hours; sugar and part of the water in which the fruit has been soaked should be added to it in the pie dish.
4. Fruit preserved in water is ready for putting into the pie dish; it may be necessary to keep back part of the juice; the amount of sugar to be added depends on the tartness of the fruit.
5. Tinned fruit preserved in syrup should not require sugar.

DROP SCONES.

Materials—½ lb. flour; 1 teaspoonful carbonate of soda; ½ teaspoonful salt; 2 gills sour milk or butter milk; 1 dessertspoonful sugar.

Utensils—Sieve; bowl; wooden spoon; cup; greased paper; frying-pan.

Method—

Sift flour, carbonate of soda, and salt into a bowl.
2. Add the sugar; mix well; add sour milk or butter milk.
3. Beat the mixture until it is smooth.
4. Rub greased paper over the bottom of a hot frying-pan.
5. Drop small tablespoonfuls of the mixture separately on the hot greased pan.
6. Cook until bubbles appear on the upper side; turn; cook under side until it is golden brown.

Note—If sour milk or butter milk is not obtainable, sweet milk, to which 1 teaspoonful of cream of tartar or ½ teaspoonful tartaric acid has been added, may be used.

STEAK AND KIDNEY PIE—FLAKY PASTRY.

Materials—For filling: 1 lb. steak; 2 sheep's kidneys or ½ ox kidney; 1 slice bacon; 1 tablespoonful flour; 1 teaspoonful salt; ¼ teaspoonful pepper; 1 teaspoonful chopped onion; 1 cup water. For pastry: 6 oz. flour; ½ teaspoonful baking-powder; 1 teaspoonful butter; ½ gill water; 3 oz. lard or dripping.

Utensils—Board; knife; 2 pie dishes; bowl; sieve; rolling-pin; brush.

Method—

1. Cut bacon and kidneys into pieces; slice the meat into strips or squares about ½ an inch thick.
2. Roll all the pieces in flour, pepper, and salt; arrange them in a pie dish, placing a piece of kidney, a piece of kidney suet, and a small piece of bacon on each slice of steak; sprinkle each layer with minced onion.
3. Add water; cover with a second pie dish; cook in a moderate oven for 30 minutes; cover with flaky pastry.

For flaky pastry:

4. Sift flour, baking-powder, and salt into a bowl.
5. Rub in butter with the tips of the fingers; add water slowly; work into a dough.
6. Turn out on a floured board; knead lightly; roll out into a square.
7. Cover the surface with one-third of the lard or dripping broken up into small pieces.
8. Fold in three; place with the open end towards you; roll out, working only from you.
9. Repeat 7 and 8 twice; fold again in three; roll out into the shape of the pie dish.
10. Cut a strip of pastry about ½ an inch wide; moisten the edge of the pie dish; cover the moistened edge with the strip of pastry.
11. Moisten the strip of pastry; place the remainder of the pastry over the pie dish; pressing the edge close to the moistened strip.
12. Trim the edges, cutting with a sharp knife downwards close to the rim of the dish.
13. Make a hole in the middle of the pie; decorate with leaves cut out of the scraps of pastry trimmed from the sides.
14. Brush over with milk or beaten egg; bake in a hot oven for 30 minutes.

PANCAKES.

Materials—2 oz. flour; 1 egg; 1 gill milk; pinch of salt; 1 tablespoonful sugar; 1 lemon.

Utensils—Bowl; sieve; cup; basin; fork; whisk; frying-pan; knife; brown paper; lemon-squeezer; d'oyley; dish.

Method—

1. Sift flour and salt into a bowl.
2. Add beaten yolk of egg and milk; mix well.
3. When smooth add the stiffly-beaten white of egg.
4. Heat dripping in a frying-pan; pour in enough batter to make a very thin layer in the pan.
5. Cook till slightly browned on the lower side; turn quickly; cook for 1 minute on the other side.
6. Lift out; drain on brown paper; roll up; sprinkle with lemon juice and sugar; serve on a d'oyley on a hot dish.

Note—Pancakes may be served piled in layers with jam between each layer; the top pancake is sprinkled with sugar; portions are cut in wedges for serving.

ABERDEEN SAUSAGE.

Materials—1 lb. steak; 2 oz. bacon; ½ cup white bread crubs; 1 tablespoonful flour; 1 tablespoonful sauce; 1 egg; pepper and salt to taste; ½ cup brown bread crumbs.

Utensils—Mincer; knife; bowl; pudding cloth; saucepan.

Method—

1. Mince the steak and bacon.
2. Put meat, bacon, bread crumbs, pepper, salt, and flour into a mixing bowl.
3. Add sauce and egg; mix thoroughly; form into a sausage.
4. Tie securely in a damp cloth.
5. Place in boiling water and boil for 2 hours.

Roll in bread crumbs and serve cold; garnished with parsley.

GERARD STEAK.

Materials—1 lb. topside steak; 1 dessertspoonful mustard; 1 dessertspoonful sugar; 2 tablespoonfuls vinegar; salt and pepper.

Utensils—Baking dish; basin; iron spoon; board; rolling-pin; cup.

Method—

1. Attend to the oven.
2. Place well-beaten steak in baking dish.
3. Mix together mustard, sugar, flour, salt, and pepper to a soft paste with vinegar.
4. Pour over steak and rub in; allow to stand 1 hour; turn and rub.
5. Add 1 cup of cold water.
6. Place in hot oven and cook for 1 to 1½ hours.
7. Service on hot dish with the gravy.

Note—Onions or tomatoes may be sliced and cooked with the meat.

STUFFED STEAK.

Materials—For forcemeat: 1 cup bread crumbs; 1 small onion; 1 dessertspoonful herbs; 1 dessertspoonful dripping; 1 egg or ¼ cup of milk.

For other: 1 lb. steak; 1 dessertspoonful vinegar; salt; pepper; dripping.

Utensils—Knife; bowl; board; rolling-pin; string; frying-pan, and saucepan or baking tin; cup; wooden spoon; dish; gravy boat.

Method—

For seasoning or forcemeat—

1. Peel and cut up onion finely.
2. Put bread crumbs, onion, herbs, dripping, salt and pepper into a basin; mix well; bind with egg or milk.
3. Beat steak with a rolling-pin; place seasoning on steak; roll up tightly and tie into shape; roll in flour, pepper, and salt.

4. Brown in smoking fat; drain on paper.
5. Put into saucepan; add sufficient boiling water to cover the meat; add vinegar; simmer for 2 hours.
6. Remove meat; thicken gravy with blended flour; add salt and pepper to taste.
7. Return meat to the saucepan; bring to boiling point.
8. Serve on a hot dish; pour some gravy over the meat; serve the remainder in a gravy boat.

Notes—

1. Stuffed steak may be baked; directions for roasting or baking should be followed instead of instructions 5 to 9 given above; gravy should be made as for roast beef.
2. By cutting the meat into slices about 4 inches square and half an inch thick, and placing seasoning or a slice of bacon on each piece, beef olives may be made.
3. Savoury chops may be prepared and cooked similarly.

LANDSCAPE GARDENING.

The landscape gardener must possess a good deal of artistic taste, as he deals with the landscape and its improvement. Should alterations be necessary, they must be carried out in as natural a manner as possible, and they must be in unison with the surrounding country. Any existing natural features may be made the most of.

If trees shut out a desirable view, they may with care be removed. Tree thinning also becomes necessary when some are spoiling others. It is better to have one good specimen than several poor ones. When tree planting, the gardener must look forward, and consider their size when maturity is reached.

Broad stretches of lawn may be broken up with shrubs or specimen trees, or beds of flowers. The character of the soil and the situation must be taken into consideration when planting. It is of no use to plant trees or shrubs that are not likely to succeed, and if doubtful ones are included, they must be in positions where they can be easily replaced should they fail. The character of the dwelling must also be taken into consideration.

Vista making is an important part of landscape gardening, and to carry it out the various points of vantage have to be ascertained and their values determined. The outline of the landscape from the various vantage points must be undulating, not straight or unbroken, and though special hues in greenery may be made the most of, they must not be repeated until the eye wearies of them.

Paths should be as few as possible, and each should be made for some definite purpose. They should run in bold but graceful curves, especially when made of gravel.

If summer houses are included they should not stand out aggressively, and they should be covered with creepers as quickly as possible.

FLOWERING SHRUBS.

Lagerstræmia indica varieties.—There are many beautiful forms of this shrub on the market, and the finest varieties have been raised in Queensland—*L. Matthewsii* and *L. Eaversiana*; the colours of both are lilac, but *Matthewsii* is the darker shade. The heads of bloom of both varieties attained a length of about 24 in., and the individual flowers are a couple of inches across. The plant may be grown in any small garden, and the size may be kept at the will of the gardener. Specimens growing in Brisbane range from a few feet high to 20 ft.

The plant stands severe trimming; in fact, it stands the knife so well that it can be grown almost any height by being cut back in July every year, like a grape vine. One of the finest specimens of *L. Matthewsii* can be seen growing on the river side of the Customs House garden. Plants are easily raised from cuttings taken from the previous year's wood and planted during July and August. Also plants well established may be purchased at any of the nurserymen's stores.

Gardenias.—In the earlier days of Brisbane there were few gardens without a gardenia; now they are rarely seen. *G. Thumbergii* is one of the varieties that should be grown. The flowers are pure white, exquisitely scented, and the foliage of all the varieties are a glossy green. These plants are not too fond of pruning, and should be allowed to grow in their own way. *Gardenia florida* is mostly grown

for florists' use, the flowers being perfect in form and not having the heavy perfume of the other varieties. All the gardenia family are subject to scale diseases, but are easily kept clean by occasional sprayings with boiler water that has plenty of soap in solution. The plants never attain any size, so are very useful in small gardens.

Oleander.—In the northern part of the State these plants flourish, and are much admired by visitors from the Southern States and overseas.

The plants attain a fair size if not kept within bounds. In some of our northern towns it is quite common to see plants 20 to 30 ft. high, and of many colours. The plants are grown in Brisbane, but by a few only; yet they grow just as well here as in the North. The smaller growing varieties should be more extensively grown, and the pink "Carnea," white "Madonna," and carmine "Delphine" are all good old varieties.

When growing the plants in small gardens it is necessary from their earliest stages of growth to keep them well headed back, the young wood of the previous year being the flowering wood.

Lantana.—The small varieties of lantana are not in common with the pest scattered all over Queensland, and are very beautiful when trained as hedges or shrubs. The tangerine-coloured variety and the canary-yellow variety are the two usually grown in Southern Queensland. Splendid specimens of these are growing in the Botanic and Museum gardens. The plants flower for nine months of the year, and will grow in almost any soil and will stand fairly hard conditions.

TRANSPLANTING FRUIT TREES.

The transplanting of partially developed fruit trees is seldom attempted on account of the risk of failure and the trouble entailed in endeavouring to retain sufficient fibrous roots to ensure a reasonable prospect of success. Trees up to five or six years old, where subject to the necessary preliminary treatment, can not only be removed without risk of failure, but transported satisfactorily over long distances. It will be recognised that the sustenance of the plant is absorbed by the small or fibrous roots in the immediate vicinity of their terminals, and by inducing a profusion of these within a short radius of the stem the chances of failure are practically nil. A profusion of small roots may be ensured by cutting through at the desired distance from the stem (15 to 24 inches, according to the size of the tree) all roots to a depth of 18 inches. In so doing a trench is made around the tree, and the end of roots carefully pared if the cutting has not been 'clean.'' The trench is then refilled with soil containing a good supply of humus, and in about three months' time the original root ends will have developed a good supply of fibres. At the time of removal these are not interfered with more than can be avoided, the necessary excavation for removing the tree from its original position and severance of any lower roots being made beyond the terminals of the young root growth. The head of a large tree should be materially shortened at the time of removal. The cutting of roots in the first instance should be performed when the tree is in a domant state; in the case of citrus, conditions are generally favourable about March. Tropical varieties handled in this manner can be removed at almost any time after sufficient roots have formed and hardened, and may be first treated at any time of the year at the period known as "between growths."

FLOWER GARDEN.

All the roses should have been pruned some time ago, but do not forget to look over them occasionally, and encourage them in the way they should go by rubbing off any shoots which tend to grow towards the centre. Where there is a fine young shoot growing in the right direction, cut off the old parent branch which it will replace. If this work is done gradually, it will save a great deal of hacking and sawing when next pruning season arrives. Trim and repair the lawns. Plant out antirrhinums (snapdragons), pansies, hollyhocks, verbenas, petunias, &c. Sow zinnias, amaranthus, balsam, chrysanthemum, marigolds, cosmos, coxcombs, phloxes, sweet peas, lupins; and plant gladiolus, tuber-roses, amaryllis, pancratium, ismene, crinums, belladonna, lily, and other bulbs. In the case of dahlias, however, it will be better to place them in some warm, moist spot, where they will start gently and be ready to plant out in a month or two. It must be remembered that this is the driest of our months. During thirty-eight years the average number of rainy days in August was seven, and the mean average rainfall 2.63 in., and for September 2.07, increasing gradually to a rainfall of 7.69 in. in February.

KITCHEN GARDEN.

Nearly all spring and summer crops can now be planted. Here is a list of seeds and roots to be sown which will keep the market gardeners busy for some time: Carrots, parsnips, turnips, beet, lettuce, endive, salsify, radish, rhubarb, asparagus, Jerusalem artichoke, French beans, runner beans of all kinds, peas, parsley, tomato, egg-plant, sea-kale, cucumber, melon, pumpkin, globe artichokes. Set out any cabbage plants and kohl-rabi that are ready. Towards the end of the month plant out tomatoes, melons, cucumbers, &c., which have been raised under cover. Support peas by sticks or wire netting. Pinch off the tops of broad beans as they come into flower to make the beans set. Plough or dig up old cauliflower and cabbage beds, and let them lie in the rough for a month before replanting, so that the soil may get the benefit of the sun and air. Top-dressing, where vegetables have been planted out with fine stable manure, has a most beneficial effect on their growth, as it furnishes a mulch as well as supplies of plant food.

THE CARE OF THE LAWN.

For a lawn to be a success it must be carefully made in the first place. Good drainage is essential, for stagnant water-logged soil encourages weeds and kills the grass. The soil should be rich in plant food. Give the ground a heavy dressing of good manure, and thoroughly dig it over. Enough time should then be allowed for the soil to settle, as it must be firm when the grass is planted or there will be a series of hills and hollows shortly after. In addition to the manure apply the following mixture at the rate of 3 oz. to the square yard, forking or raking it well into the top spit of the soil:—2 lb. superphosphate of lime, 1 lb. bonemeal, and 1 lb. sulphate of ammonia.

Early in the spring, as the grass begins to grow, a heavy roller should be passed several times over the ground.

Lawns showing bare patches will require a dressing during the autumn, and the mixture previously mentioned will be found very suitable, and will keep the grass well nourished. Wood ashes and soot, combined or not, will also be found beneficial. All dressings should be applied during showery weather. If soil poverty is the cause of a patchy lawn, it is best to rake over in the autumn with a sharp-toothed rake, and dress with a good layer of fine soil and wood ashes.

PLATE 73.
Brisbane's Water Supply—High level filter beds, Mount Crosby.

Orchard Notes for August.

THE COASTAL DISTRICTS.

THE bulk of citrus fruits, with the exception of late ripening varieties, will now have been marketed, and cultural operations, pruning, spraying, &c., should be receiving attention. Where trees show indication of impaired vigour, pruning should be heavy, both in respect of thinning and shortening branches. Where trees are vigorous and healthy a light thinning only will be necessary, except in the case of the Glen Retreat Mandarin, which in coastal lands is invariably disposed to produce a profusion of branches, with consequent over-production and weakening of the constitution of the tree in addition to the fruit being small and not of the best quality. Where white louse is present on the main stem (where it almost invariably makes its first appearance) or branches, spraying with lime sulphur solution in the proportion of one part of the concentrate to ten parts of water after the centre of the tree has been opened up by pruning will be found most beneficial.

In dealing with trees which show signs of failing, investigation should be made near the ground level for indications of collar rot, and in the North Coast district particularly, for the presence of the weevil root-borer which may attack the roots in the vicinity of the thin bases or at some feet distant. A very light application of paradichlor, buried a few inches under the soil in circles around the tree and the surface stamped firm, is considered efficacious in destroying the pest. The distance between the circles (shallow openings connected throughout) should not be more than 18 inches. It may be necessary to repeat the application at three to four weeks' intervals.

Spraying with Bordeaux mixture is desirable as it will, if properly applied, destroy the spores of various fungi later attacking both foliage and fruit.

Where for any reason healthy trees of vigorous constitution are unprofitable they should now be headed back—in fact, the whole of the top removed, leaving only a few selected "arms" of previous branches, all other branches being cut clean away at their base. Three or four main arms, whose length will vary from 2 to 4 feet according to the size of the tree, will form the future head of the tree, and from these numerous shoots will originate; these shoots in turn are reduced according to circumstances, usually from two to five on each arm, and given fair attention they will be in a fit condition to receive selected buds from a prolific tree by next autumn. It is advisable when the shoots intended for budding have attained a length of about 6 inches to nip off their terminals for the purpose of stiffening their growth, otherwise they are liable to be blown off by winds. All branches or parts removed in pruning should be carefully collected and burned. Applications against pests and disease could hardly be satisfactory if the material for reinfestation is available throughout the orchard.

Working the land is essential, and disc implements give best results. Before ploughing it is advisable to apply the necessary fertilizer, not just around the trees beneath the branches, but over the whole orchard, the feeding roots mainly extending beyond the extremities of the branches. The depth to which ploughing should be effected will depend on the nature of the soil and its original preparation. Where the subsoil is of a permeable nature, or has been broken up in the first instance, ploughing could be much deeper than on land where due consideration had not been given to this practice. It will also be noted that among some of our light loams fertility is confined to a shallow depth, where it would be futile to persist in deep ploughing to force the roots into a subsoil from which they could derive but little sustenance. Following upon ploughing, the soil should be further treated until finely broken; the implement necessary will depend upon the constituency of the soil. Generally a good harrow will meet all requirements. On the completion of ploughing between rows an open furrow should not be left on the border or margin, but two or three furrows should be turned back to fill this and the whole then worked sufficiently to leave an even surface throughout the orchard. Except for the purpose of turning in fertilizer or green manure, a good type of disc cultivator can be substituted for the plough and will give at least an equal result.

The planting of trees may be continued and with the exception of custard apples (which should be left until the end of August) should be expedited. The attention of citrus growers should be confined mainly to good varieties like Joppo, Siletta, and late Valencia. The preserving of orange juice will very materially assist in the absorption of our crop, and the fact that the trees develop much more rapidly in this State

than in Southern producing regions is distinctly in our favour; also our fruit contains a much higher sugar content. This, however, is not to be accepted as an invitation to continue the practice of sending immature fruit to the Southern markets.

Grape vines should be pruned, and where cuttings for planting are required these should be selected, trimmed, and heeled in slightly damp soil. Canes intended for cuttings should not be allowed to lie about and dry out, but treated the day they are severed from the plant. Cuttings are frequently made of excessive length. Ten to twelve inches is a fair length, allowing for insertion in the soil to admit of the top bud with a short section of the internode to protrude. Growth is only desired from the upper or exposed bud.

THE GRANITE BELT, SOUTHERN AND CENTRAL TABLELANDS.

ALL pruning other than that applied to peaches and varieties which are late in coming into growth should be completed this month, and the planting of young trees, if not already done, should no longer be delayed. Early planting is preferred, the sooner after the fall of leaves the better. The time is opportune (when there is indication of the buds swelling) to work over (where the stock is reasonably vigorous) unprofitable trees. Strap grafting, as advised by the local field officers, is the most satisfactory method of top-working deciduous trees.

The pruning of vines should be postponed as long as circumstances permit, and these can only be gauged on actual observation as they are subject to much variation.

Late spraying against San José scale where present should be applied with an efficient oil emulsion before any growth appears. Each particular brand has its advocates. Where the scale is persistent a 2 per cent. solution of Volck may be applied subsequent to the appearance of foliage. Both of these sprays are efficacious against peach or other aphis at a much reduced strength. One per cent. has given satisfactory results. The usual winter working of the land is essential for the retention of moisture and aeration of the soil, but in shallow soils in which many orchards are planted deep working is most detrimental. The matter of seedling stocks for apples and the inferior plants frequently received from Southern nurseries prompts a query as to how many seeds have been stratified for spring planting, and if any effort is being made towards raising a local supply of nursery stock.

Farm Notes for August.

THE most important work during August will be the preparation of the land for all spring-sown crops. The better the cultivation the better the results that can be expected. Potato planting will be in full swing this month, and in connection with this crop the prevention of fungoid diseases calls for special attention. Where possible, seed potatoes should be selected from localities which are free from disease; they should be well sprouted, and, if possible, should not exceed 2 oz. in weight. Seed potatoes of this size are more economical to use than those large enough to necessitate cutting. However, if only large-sized seed are procurable, the tubers should be cut so that at least two well-developed eyes are left. The cut surfaces require to be well dusted with slaked lime or wood ashes as soon as possible after cutting. If considered necessary to prevent possible infection by fungoid diseases, potatoes should be dipped in a solution of 1 pint of 40 per cent. formalin to 15 gallons of water, leaving them immersed for one hour. The bags used should also be dipped and thoroughly dried. The potatoes should be spread out and dried before rebagging. Where cut tubers are to be sown, they should be dipped before cutting.

In localities where all danger from frosts is over, sweet potato cuttings may be planted out. This crop deserves more atttention owing to its value for both culinary and stock food purposes.

Arrowroot may also be planted this month in suitable localities.

With the advent of warmer weather weed growth will increase, and cultivators will be kept busy in growing crops, and land being prepared for sorghums, millets, maize, cotton, and summer growing crops generally.

RAINFALL IN THE AGRICULTURAL DISTRICTS.

TABLE SHOWING THE AVERAGE RAINFALL FOR THE MONTH OF MAY, IN THE AGRICULTURAL DISTRICTS, TOGETHER WITH TOTAL RAINFALL DURING MAY, 1934, AND 1933, FOR COMPARISON.

Divisions and Stations.	Average Rainfall.		Total Rainfall.		Divisions and Stations.	Average Rainfall.		Total Rainfall.	
	May.	No. of Years' Records.	May. 1934.	May. 1933.		May.	No. of Years' Records.	May. 1934.	May. 1933.
North Coast.	In.		In.	In.	*Central Highlands.*	In.		In.	In.
Atherton	2·10	33	4·19	2·05	Clermont	1·27	63	2·12	0·44
Cairns	4·50	52	4·85	4·59	Gindie	0·91	35	..	..
Cardwell	3·61	62	4·06	5·26	Springsure	1·25	65	1·08	0·37
Cooktown	2·83	58	2·85	0·95					
Herberton	1·68	48	2·66	3·47					
Ingham	3·62	42	4·20	6·32					
Innisfail	12·24	53	26·34	8·85					
Mossman Mill	3·81	21	2·96	4·17	*Darling Downs.*				
Townsville	1·30	63	0·24	0·48					
Central Coast.					Dalby	1·27	64	3·06	0·23
					Emu Vale	1·17	38	0·37	0·39
Ayr	1·13	47	0·80	0·61	Hermitage	1·21	28	..	0·34
Bowen	1·32	63	0·37	1·07	Jimbour	1·17	46	2·95	0·32
Charters Towers	0·79	52	0·97	0·37	Miles	1·46	49	3·16	0·14
Mackay	3·71	63	3·74	1·32	Stanthorpe	1·86	61	0·28	1·17
Proserpine	4·33	31	5·39	4·58	Toowoomba	2·16	62	2·34	0·71
St. Lawrence	1·77	63	1·95	0·64	Warwick	1·54	69	0·15	0·42
South Coast.									
Biggenden	1·69	35	1·61	0·64	*Maranoa.*				
Bundaberg	2·62	51	1·08	0·98					
Brisbane	2·78	83	2·39	0·55	Roma	1·41	60	0·77	0·20
Caboolture	2·81	47	2·89	..					
Childers	2·09	39	1·92	0·55					
Crohamhurst	4·83	41	5·89	0·40					
Esk	1·94	47	2·10	0·21					
Gayndah	1·55	63	2·41	0·25					
Gympie	2·82	64	2·18	0·69	*State Farms, &c.*				
Kilkivan	1·81	55	1·92	0·62					
Maryborough	2·99	63	3·24	0·95	Bungeworgorai	0·90	20	0·61	0·10
Nambour	4·63	38	7·63	1·03	Gatton College	1·52	35	1·30	0·45
Nanango	1·50	52	2·93	0·26	Kairi	2·01	20	..	2·82
Rockhampton	1·64	63	0·82	0·47	Mackay Sugar Experiment Station	3·24	37	3·24	1·72
Woodford	2·85	47	3·94	0·02					

GEORGE G. BOND, Divisional Meteorologist.

CLIMATOLOGICAL TABLE—MAY, 1934.

COMPILED FROM TELEGRAPHIC REPORTS.

Districts and Stations.	Atmospheric Pressure. Mean at 9 a.m.	Shade Temperature.						Rainfall.	
		Means.		Extremes.				Total.	Wet Days.
		Max.	Min.	Max.	Date.	Min.	Date.		
	In.	Deg.	Deg.	Deg.		Deg.		Points.	
Cooktown	29·93	81	70	84	13, 29	62	10	285	8
Herberton	..	70	57	78	2, 5	43	11	266	14
Rockhampton	30·11	78	60	83	1, 2, 3, 4	54	28	82	6
Brisbane	30·19	72	56	78	1	49	29	239	13
Darling Downs.									
Dalby	30·18	71	46	77	1	35	30	306	8
Stanthorpe	..	65	40	72	13	25	31	28	7
Toowoomba	..	67	47	79	19	35	15	134	7
Mid-Interior.									
Georgetown	29·95	85	62	93	2	48	11	7	2
Longreach	30·10	82	55	89	2	50	9, 31	38	1
Mitchell	30·18	74	44	79	3	35	2, 25, 31	18	3
Western.									
Burketown	29·98	87	66	92	4, 14	55	6	20	2
Boulia	30·08	81	55	88	12	47	9	..	..
Thargomindah	30·18	74	53	80	11	44	31	29	2

ASTRONOMICAL DATA FOR QUEENSLAND.

TIMES COMPUTED BY D. EGLINTON, F.R.A.S., AND A. C. EGLINTON.

TIMES OF SUNRISE, SUNSET, AND MOONRISE.

AT WARWICK.

	July, 1934.		August, 1934.		MOONRISE. July, 1934.	August, 1934.
	Rises.	Sets.	Rises.	Sets.	Rises.	Rises.
					p.m.	p.m.
1	6·45	5·7	6·35	5·21	9·38	11·32
2	6·45	5·7	6·34	5·22	10·40	a.m.
3	6·45	5·7	6·33	5·23	11·41	12·33
4	6·45	5·8	6·32	5·23	a.m.	1·30
5	6·45	5·8	6·32	5·24	12·40	2·27
6	6·45	5·8	6·31	5·24	1·40	3·20
7	6·45	5·9	6·31	5·25	2·39	4·10
8	6·45	5·9	6·30	5·25	3·36	4·55
9	6·44	5·9	6·29	5·26	4·31	5·37
10	6·44	5·10	6·29	5·26	5·24	6·10
11	6·44	5·10	6·28	5·27	6·12	6·42
12	6·44	5·10	6·27	5·27	6·57	7·14
13	6·44	5·11	6·26	5·28	7 35	7·39
14	6·44	5·11	6·25	5·28	8·9	8·9
15	6·44	5·12	6·24	5·29	8·39	8·38
16	6·43	5·12	6·23	5·30	9·10	9·9
17	6·43	5·13	6·22	5·30	9·35	9·47
18	6·43	5·13	6·21	5·31	10·5	10 29
19	6·42	5·14	6·20	5·31	10·36	11·18
						p.m.
20	6·42	5·14	6·19	5·32	11·8	12·17
21	6·41	5·15	6·18	5·32	11·47	1·22
					p.m.	
22	6·41	5·15	6·18	5·32	12·34	2·31
23	6·40	5·16	6·17	5·33	1·30	3·43
24	6·40	5·16	6·16	5·33	2·35	4·54
25	6·39	5·17	6·15	5·34	3·44	6·4
26	6·39	5·17	6·14	5·34	4·55	7·9
27	6·38	5·18	6·13	5·35	6·9	8·14
28	6·38	5·18	6·12	5·35	7·18	9·17
29	6·37	5·19	6.11	5.36	8·24	10·20
30	6·37	5·19	6·10	5·36	9·27	11·22
31	6·36	5·20	6·9	5·37	10·29	..

Phases of the Moon, Occultations, &c.

4 July.	☽	Last Quarter	6	28 a.m.
12 ,,	●	New Moon	3	6 a.m.
20 ,,	☾	First Quarter	4	53 a.m.
26 ,,	○	Full Moon	10	9 p.m.

Apogee, 13th July at 4.12 a.m.
Perigee, 26th July at 8.18 p.m.

On the 5th the Earth will be in that part of its orbit most distant from the Sun, at a distance of over 94 million miles. At 11 o'clock at night the Moon will be passing Uranus, which requires binoculars or telescope to be seen. Two days later the Moon will be passing from west to east of Venus which will then be more than 100 million miles from the Earth.

At 5 o'clock in the morning on the 10th the Moon will be passing Mars, 3 degrees northward of it, shortly before they both rise over the eastern horizon. A glimpse of this nearness may be obtained before daylight supervenes.

Mercury will be in inferior conjunction with the Sun on the 11th. As Mercury will be nearly 7 degrees further north than the Sun the planet will not actually pass exactly between the Earth and it.

The interesting spectacle of a partial eclipse of the Moon will be afforded on 26th July. The Moon will begin to dip into the shadow of the Earth at 7.50 p.m., but the eclipse will not become generally noticeable until 8.54 p.m., when a dark notch will begin to grow low down on its north-eastern edge. The Moon, having risen about 5 p.m., will be four hours high and be about 20½ degrees south, 7 degrees N.N.E. (nearly) of the zenith of Brisbane. The dark notch on the Moon will increase till 10.15 p.m., when the Moon will be rather more than half immersed. After this it will gradually decrease until 11.36 p.m., when the Moon will emerge from the darker shadow, but still be in the almost unnoticeable penumbra for an hour and ten minutes longer.

Mercury on the 31st will reach its greatest elongation, 19 degrees west of the Sun, and will rise one hour 12 minutes before it.

Mercury sets at 6.17 p.m., one hour 10 minutes after the Sun on the 1st; on the 15th it rises 34 minutes before the Sun.

Venus rises at 4.4 a.m. on the 1st and at 4.25 a.m. on the 15th.

Mars rises at 5.24 a.m. on the 1st and at 5.11 a.m. on the 15th.

Jupiter rises at 12 noon on the 1st and sets at 12.24 a.m. on the 15th.

Saturn rises at 8.47 p.m. on the 1st and at 7.50 p.m. on the 15th.

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2 Aug.	☽	Last Quarter	4	27 p.m.
10 ,,	●	New Moon	6	46 p.m.
18 ,,	☾	First Quarter	2	33 p.m.
25 ,,	○	Full Moon	5	37 a.m.

Apogee, 9th August, at 7·12 a.m.
Perigee, 24th August, at 5·48 a.m.

For places west of Warwick and nearly in the same latitude, 28 degrees 12 minutes S. add 4 minutes for each degree of longitude. For example, at Inglewood, add 4 minutes to the times given above for Warwick; at Goondiwindi, add 8 minutes; at St. George, 14 minutes; at Cunnamulla, 25 minutes; at Thargomindah, 33 minutes; and at Oontoo, 43 minutes.

The moonlight nights for each month can best be ascertained by noticing the dates when the moon will be in the first quarter and when full. In the latter case the moon will rise somewhat about the time the sun sets, and the moonlight then extends all through the night; when at the first quarter the moon rises somewhat about six hours before the sun sets, and it is moonlight only till about midnight. After full moon it will be later each evening before it rises, and when in the last quarter it will not generally rise till after midnight.

It must be remembered that the times referred to are only roughly approximate, as the relative positions of the sun and moon vary considerably.

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